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THE

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No. XXXI. SECOND SERIES. Dec. 1804.

Specification of the Patent, granted to JOHN SHARRER WARD, *of Bruton, in the County of Somerset, Silk Throwster; for a Machine, upon new and improved Principles, for the Purpose of doubling either Silk, Cotton, Flax, Hemp, Worsted Yarn or other Threads.*

Dated December 30, 1800.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Sharrer Ward do hereby declare, that my said invention is described in manner following; that is to say: whatever number of threads are required to be doubled together of silk, worsted, cotton, flax, &c. they may by means of this invention be doubled to the greatest certainty, for if at any time any one of the threads, or union of threads, to be so doubled, should break, it will immediately stop the other thread or threads until the broken thread shall be repieced, which secures a constant double thread, or union of threads;

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and the manner in which the same is to be performed is described and ascertained in the plan hereunto annexed, and which is explained and referred to in the letters, figures, and words following; that is to say:

Fig. 1, (Plate I.) A, is a roller, turning round vertically or otherwise; with it is carried the bobbin B, which draws the threads C C from the bobbins D D, and consequently the balls E E and the thread wires F F will move round on the pins G G. H H, are two wood or iron standards, at the tops of which are hung two regulating thread wires I I. When either of the threads C C break, the thread wire through which it passes falls down, and the tail part K rises up to a level with the ball E, and stops the other thread wire F from going round, and consequently the thread that passes through it, and prevents the bobbin B from taking it up; but the roller A continues in motion. L L, are guide wires for the threads to pass over. M, is a slide, moved by a stort wheel or crank to lay the threads level on the bobbin.

Fig. 2, is another doubling machine; the form varied, but the principle the same as Fig. 1. A, a roller, turning vertically, whereon lies a smaller one marked B, the axis of which goes through the bobbin. C, a slide, for the same purpose as M in Fig. 1. D D, two bobbins, with spindles through them, on each of which is fixed a wheel E E. F F, are two thread wires, hung at G G. When either of the threads break, the wire drops between the teeth of the wheel and stops the other thread, the bobbin and roller B stopping at the same time, but the roller A continues moving as A in Fig. 1.

In witness whereof, &c.

Specification

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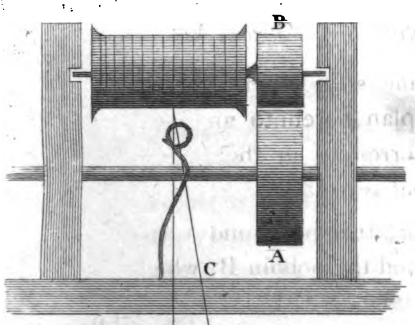

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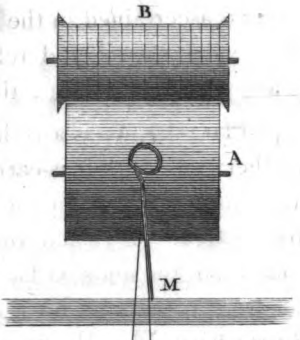
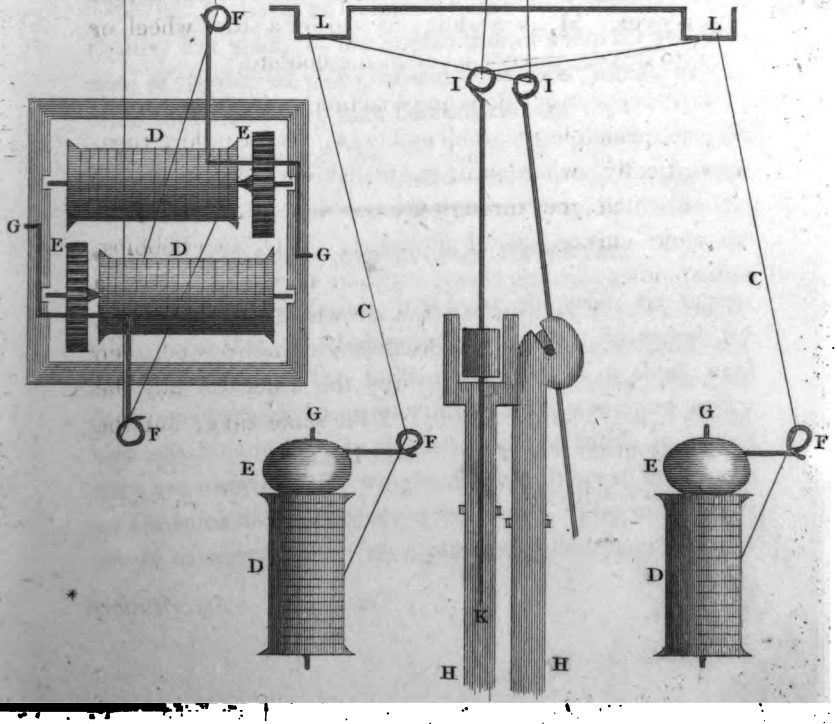


Fig. 1.



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Specification of the Patent granted to JOHN SLATER, *of Huddersfield, in the County of York, Surgeon; for a new and improved Method of manufacturing and fabricating of Cables, Shrouds, Stays, and other Articles for the rigging of Ships, of Materials never before used for that Purpose.* Dated January 19, 1804.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Slater do hereby declare, that my invention consists in substitution of metals in lieu of hemp in the fabrication of cables, shrouds, stays, and other articles for the rigging of ships, which is to be applied in the form of chain-work, and which every workman in chain-work knows how to make without farther instruction.

N. B. I claim no discovery in the construction of chains, but solely to the application of them for the purpose of rigging of ships, of whatever form, metal, or metallic substance, they may be constructed.

In witness whereof, &c.

OBSERVATIONS BY THE PATENTEE.

By way of elucidation, it is to be observed, the invention, consisting of chain-work, is chiefly intended for standing-rigging; the links are made of a short oval form, very thick in proportion to their size, and every two nearly touching in the centre of the third, in which they are inserted, the weight of the different articles to be the same as the cordage now in use. The mast-heads are to be surrounded with a plate of rolled iron or cop-

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per, to keep the shrouds from chafing. One leg of a pair of shrouds is to be received through a large link in the other, just at the place where the present kind are seized, and they are to be set up with dead-eyes (having metal straps and hooks to hook into the ends of the shrouds) and lanniards, as in the present manner. The fore-stays are to be hooked where they are now seized, and the back-stays fitted in the same manner as the shrouds.

The advantages of this invention must be obvious to every person skilled in maritime affairs, as the durability of one suit of rigging would exceed that of any ship made of the best materials; and, as there would be no sensible stretching in any climate or weather, it would entirely obviate that serious inconvenience by which many a ship has lost her masts, and ultimately both cargo and hull, as it is no easy matter, and frequently impossible, to set the shrouds up in a heavy gale, or even secure them in any manner that will preserve the masts, of which there have been too many lamentable instances.

This substitute for cordage will never require any mechanical stretching, but will always be the same, and will never be troubled with kinks, but always pliant and easy to handle, will require no serving, leathering, or chafing mats, will never require flitting, and the ratlins may be fixed to this as easy as hempen rigging. In time of action this kind of rigging will be much less liable to be cut with shot from its greater cohesion, elasticity, and slipperiness, and, in case of its being cut, may be much more easily repaired, which can be done instantly, by passing a piece of small line two or three times through the links immediately above and below the fractured link, and heaving it tight by hand, which will be a sufficient security during the engagement, and keep the ends from hanging

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hanging down; and when the action is over, a link made for the purpose, in the same form as the others, but a little stronger, and wanting a piece at one side thus C, may easily be inserted, by slackening the lanniard, which, after heaving it tight again, will look as well as ever, and be perfectly secure, till it is convenient to have it taken down and repaired at the forge.

This kind of rigging has a much lighter and more beautiful appearance to the eye, as it looks handsomely beaded, and when blacked over lightly with lamp-black and pitch is effectually preserved from rust. When the demand requires it to be made in any great quantity, the first cost will be nearly as small as that now in use; and when the time comes that it does wear out, every particle of it can be manufactured over again.

If it was adopted in the British navy, the saving would be almost incalculable to this country, and there would be no loss, as the present kind could be replaced by it as it wore out. But the want of patronage will no doubt be a means of preventing the country from reaping the advantage it would otherwise derive from its adoption. The only objection which has been made against it, and which seems to have any weight at first sight, is its supposed attraction for the electric fluid; but upon mature consideration, founded upon observation, it will have no weight at all except in its favour. It is well known that iron in particular, and metallic substances in general, are conductors to lightning; but that the power of attraction at any distance is very trifling is evident from the many spires with iron rods in them having stood uninjured for ages, also ships masts with iron spindles for their vanes. Buildings furnished with electric rods, iron balconies, &c. are seldom struck, and when they are, it as frequently happens they are injured where the metal is not

as

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as where it is; it is certain when the fluid does strike the metal, it will follow every turn it makes till it reaches the surface of the earth, which is a strong reason for the adoption of metallic rigging, as in case of a ship being struck with lightning, the shrouds having small appendages to let down, it would be conducted into the water without injury to the crew, ship, or cargo, except a man happened to be on the shrouds where, or leading from where it fell; and it is presumed that accidents of this kind would more seldom happen than does at present, as the men upon deck, in the tops, and on the yards, would be almost intirely secure, which is not the case at present; and in climates where the surrounding atmosphere is pregnant with the electric fluid, no accumulation could take place, as the rigging would be continually conducting it harmless to the surface, in the same manner as a chain suspended from the conductor of an electric machine, and resting on the ground, would prevent a person touching it from receiving a shock.

The chain-work is recommended to be made of the toughest iron, and well welded, as indifferent iron would not answer the purpose; it likewise may be made of copper, &c.

The Patentee's engagements being foreign from the nature of this invention, he consequently cannot attend to the subject of it, and therefore wishes to dispose of the patent. He is willing either to part with it wholly or in shares.

Specification

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Specification of the Patent granted to Mr. JOHN BYWATER, *of the Town and County of the Town of Nottingham; for a Method of clothing and unclothing of the Sails of Windmills while in Motion, (providing they are made after the Dutch Manner, or as the generality of Sails are constructed,) by which the Mill may be clothed either in Whole or in Part, in an easy and expeditious Manner, by a few Revolutions of the Sails, whether they are going fast or slow, leaving the Surface smooth, even, and regular in Breadth from Top to Bottom; and in like Manner the Cloth, or any Part thereof, may be rolled or folded up to the Whip at Pleasure, by Machinery simple and durable, requiring very little Alteration of any Part of the Mill, may be fixed up in a few Days, at a comparatively easy Expense, and is equally applicable to any old Sails, however warped or bosomed, without the Necessity of having new Cloths.* Dated September 14, 1804.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Bywater do hereby describe the nature of my said invention to consist in rolling or folding up to the whip, and unrolling or unfolding again, the cloths of common windmill sails while in motion, by means of cylinders or rollers of any shape as long as the sails, with a toothed wheel at one end of each, working either directly or indirectly into two wheels without arms, which are hung so as to turn upon a ring of iron fixed to the shaft head close behind the back stocks, and which may be alternately stopped; so that the wheels at the ends of the cylinders must directly, or by means of a connexion of wheels called carriers or nuts, work into them by revolving

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volving round them through the power of the wind acting on the sails; so that the cylinders must necessarily turn round and roll up or fold, or unroll or unfold the cloth which is fastened to them, according to the respective wheel without arms, which is stopped as aforesaid, for that purpose. It appears to me necessary, lest others encroach on my patent, to describe as above the general end, result, and use of my invention, which has so long been the wish of the millers to obtain; and the attainment of which I have constantly had in view, namely, to clothe and unclothe common windmill-sails while in motion, and to leave any quantity of cloth on the sails at any time in an even breadth from top to bottom; and also to describe, as above, the principle upon which I act in as few words as possible, and in such a manner as will make the matter as plain as the case will allow. Therefore, according to what is set forth and declared, persons who shall roll or fold up to the whip, or unroll or unfold the cloths of the sails of the common windmills while in motion, whether by the means above described, or any other, without my permission, are deemed to encroach on my patent, as this effect of so clothing and unclothing of common windmill-sails was never accomplished and made known prior to my said invention. And I should deem the above description of the mode of performing the same adequate to answer all the ends of a full and plain description of my invention, to be enrolled in the Court of Chancery, as has been done in similar cases. And I think it not anywise of moment to subjoin any drawings to explain the same, as it can by no means be possible to hide or conceal the windmills so to be improved; but to comply, as strictly as possible, with the letter of the said proviso, I have given the annexed drawings and explanation.

Figs.

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Figs. 1, 2, 3, (Plate II.) are front views of the sails as unclothed, half clothed, and clothed *.

Fig. 4, a ring of iron, or other material, about four inches wide and three-quarters of an inch thick (more or less as required), whose diameter must be sufficient to embrace the shaft-head, to which it must be well secured by the stays *a a*, or otherwise.

Fig. 5, a bevelled wheel, without arms, made of iron, or other material, stayed on the edge of the ring so as to turn easily.

Fig. 6, a spur-wheel of iron, or other material, without arms, made to turn easily on four pins fixed into four ears *b b b b*, in the back of the ring; which pins are turned up at their ends to keep it steady.

Fig. 7, is one of the four spindles of iron, or other material, with a spur nut *a* and a bevelled nut *b*; this spindle passes through Fig. 4, at *c c c c*, and the nut *a* works into the spur-wheel as seen in Fig. 8, *a a a a*. The four bevelled nuts (Fig. 7, *b*) work into the bevelled wheels at the end of four cylinders *i i i i*, Figs. 1, 2, 3, and so turn them; and two of these spindles must be shorter than the others when the stocks are not flush. These cylinders are made of wood, or other materials, diameter three inches, more or less, or made octagon, or any other shape; one to be placed at the outside of the leading edge of each sail, round which the cloth is rolled (one edge being fastened on for that purpose) when the sail is unclothed. A gudgeon from the end of each cylinder runs into an iron fastened to the shaft-head, and is kept in its place by a nut screwed to

* In the specification there are three drawings, representing four vanes each, clothed, half clothed, and unclothed, but to save the space that they would have occupied in our plate we have shewn one figure only, exhibiting two vanes unclothed, one clothed, and the other half clothed.

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its end. The other end has a gudgeon *b*, which turns in the eye of the cross iron *h* at the points of the whips. *f f f f* four cylinders, similar to *i i i i*, placed on the inside the whips, one behind each sail to clothe the sails, by means of ropes *o o o o*, &c. (fastened to them and the edge of the cloth.) At the end of each of these four cylinders a nut or wheel is fixed, *e e e e*, to work into the bevelled wheel Fig. 5, whose teeth decline from the centre in proportion as these work from it, which declination must be reversed when the sails turn the contrary way, and gudgeons to run into irons either projecting from the ring or fastened to the shaft-head like the other cylinders. The gudgeons *g* keep these cylinders steady in the cross iron *h* at the point of the whips, and stays of any shape or number will keep them from springing.

Now, suppose the mill fully clothed, as Fig. 3, all the parts of my machinery revolve with it undisturbed until a lever, Fig. 9, (which turns on the centre pin *q*, Fig. 10, by which it is fastened to the braces or fencings, and whose end *b* is weighted to hang down towards the breast of the mill,) being brought into an horizontal direction by pulling a string attached to the end *a* within-side the mill, the end *b* stops the stud *b*, projecting from the inner surface or back-front of the spur-wheel Fig. 8; consequently the four spur nuts *a*, at the end of the spindle Fig. 7, (and seen at *a a a a*, Fig. 8,) roll round the spur-wheel, and the bevelled nuts *b* at the other end of the spindle work into the bevelled wheels of the outside cylinders *i i i i*, Figs. 1, 2, 3, in a straight direction behind them, and so turning the cylinders roll the cloth on them till it is rolled up to the whip. The lever is then driven sidewise (its spring *c* returning it again) from the stud in the back face of the spur-wheel by the following contrivance.

A screw

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A screw *b*, Fig. 11, is cut on the gudgeon of any one of the cylinders behind the sail, and a piece of iron *c*, Fig. 11, is tapped to fit it. The end of this iron runs into a slot in the iron *d*, Fig. 11, made fast to the shaft-head, to prevent the iron *c* from turning with the cylinder, but allows it to slide up and down so as to press on that on the iron *a*, Fig. 11, which has the eye in it, and raises the end *a* just high enough to drive the lever aside when the cloth is all rolled up, the threads of the screw adjusting it to what number of revolutions you choose to employ for that purpose. The point-end of the iron *a*, Fig. 11, is that part of it which pushes aside and passes the lever Fig. 9, and moves on its centre *c*, and must be carried under the spur-wheel so as to act behind it for that purpose: a duplicate of Fig. 11 shews it on a larger scale *. By letting go the string the miller may at any time leave the cloth on the sail where he chooses, likewise the sails may be clothed, or any part thereof, by a lever, similar to *a*, Fig. 9, stopping the stud *a*, on the edge of the bevelled-wheel Fig. 5, and driven off in a manner similar to the spur-wheel.

Fig. 12, is a stay of wood, or other material, and fixed to the stock or whip at *nnnn*, Figs. 1, 2, 3, to prevent the cylinders from springing too much. In the inside there is left room enough for the cloth to be rolled upon the cylinder through its lips in the eye of this stay. In order to keep the strings tight in all weathers, which go over the edge of the shrouds, *oooo*, &c. a cord, passing over a spring of any sort or shape, placed under the sail, is fastened to, and wound about, the upper ends of the cylinders in a direction contrary to the strings and cloth. To prevent the cloths from being driven downwards by the centrifugal force, a ring or two are left on to run along the rods in the old manner, as *p*, Figs. 2 and 3.

* The smaller drawing is omitted in the plate.

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The width of the cloth, diameter of the cylinders, and number of revolutions you choose to employ to roll up your cloth, must determine the size of the wheels. In order to fold the cloth instead of rolling it, one end of it must be fastened to the whip and lines passed across the outside of it through loops fastened to its edge, and continued over the edge of the shrouds, and connected with the cylinder or roller, of any shape, placed under the sail, or elsewhere, the other ends of the lines must also be connected with the said cylinder or roller; and when the cloth is drawn up in folds towards the whip, so much of these lines will be rolled on the cylinder one way, and off from it the other, as will be sufficient to let out the cloth again when the same cylinder, turned the contrary way, draws the cloth on the sail. By this mode I get rid of four cylinders, with their appendages, the work being in other respects the same as in rolling the cloths; but since folding gives a surface much inferior in many respects to rolling, and induces inconveniences and accidents from which the rolled surface is free, I shall advise the rolling, rather than for a small saving to endure the inconveniences of folding.

Note. The above drawings are a quarter of an inch to the foot *.

If a sudden gust of wind should arise in the absence of the miller, so as to drive the mill faster than a given velocity, a pair of centrifugal balls, like the governor of a steam-engine, may be so placed as to adjust the lever so that she may immediately unclothe herself; but as this is not an essential part of my patent, it may or may not be adopted.

In witness whereof, &c.

* In our plate Figs. 1, 2, and 3 are reduced about two-thirds less than the original, but the remaining figures are nearly on the same scale.

OBSER-

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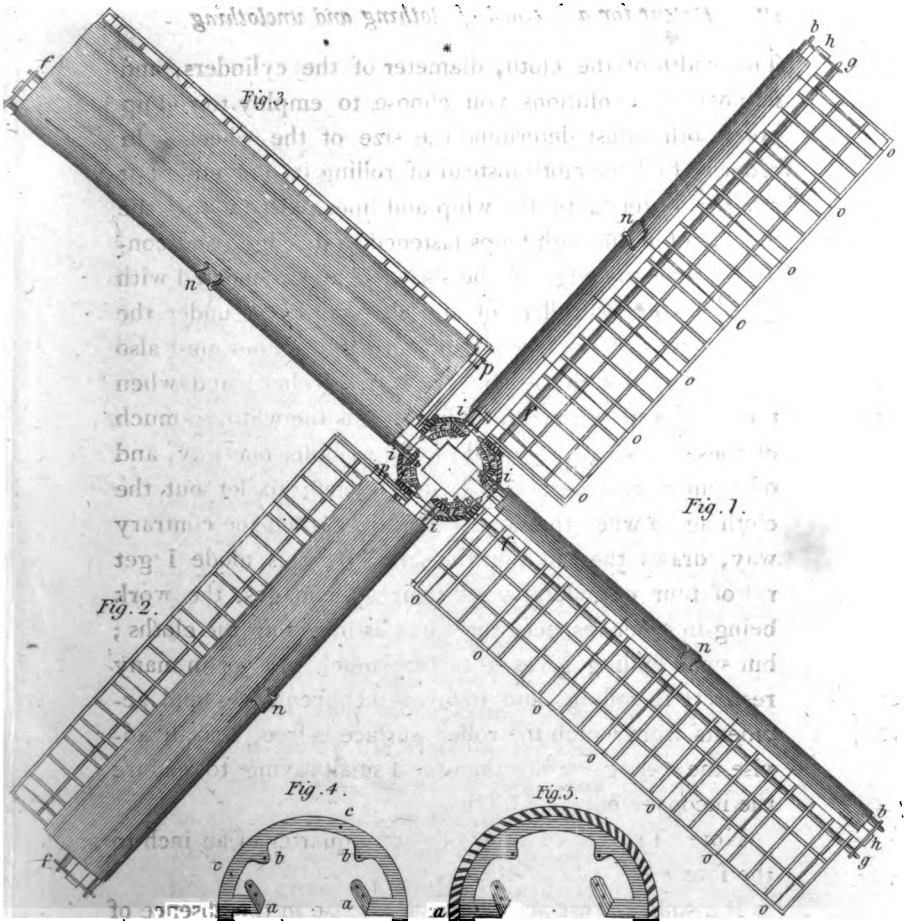

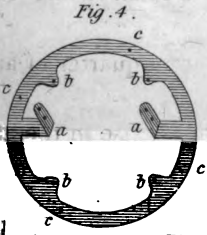

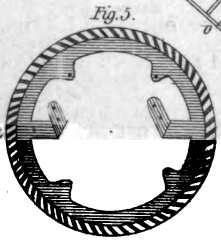

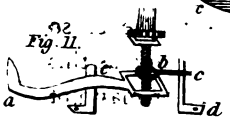

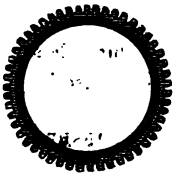

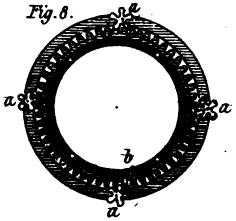

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OBSERVATIONS BY THE PATENTEE.

The various and repeated attempts that have so long been made to discover a ready and effectual method of controlling the excessive power of the wind, acting on so large a body as a windmill, engaged my attention some years since; and the eagerness shewn to obtain patents for new inventions, that were considered as improvements, led me to suppose that some great advantages, individual or national, were involved in the issue. Experience soon proved the general error that more or less pervaded all their schemes; for every one followed his predecessor in adopting sails varying from, or quite on a different construction to, those in common use, either by laying the cloth on in a different manner, or by using boards instead of cloth, hung like Venetian blinds; or by entirely taking away the shrouding and bars, and suspending the cloth at the corners by ropes; and by introducing many different contrivances; all agreeing only in one object, that of departing from the old established mode of laying the cloth on the sails in the way which common usage has sanctioned, and experience abundantly confirmed, as the best possible way of doing it. Reflecting hereon from time to time as the subject occasionally presented itself, I was at length induced to devote a small portion of the time I could spare from my regular employment to the more immediate consideration of the subject, to contrive a method that might embrace all the beneficial ends that could be wished, and which should at the same time be as free as possible from the inconveniences that, more or less, affected attempts of a similar nature. My leading design was to meet the wishes of the millers, and to do the business *in their own way*, by rolling the cloth, or any part of it, *up to the whip*, in an easy and expeditious manner, by the agency of the miller

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miller himself, who should only have to pull a rope within side of the mill, at any time he wished to reduce the cloth, to leave as much as he chose of it on the sail, and to return it again at pleasure, *the mill all the while continuing in motion.* I accordingly constructed a model, which, with successive alterations, I have so improved, as to render it every way answerable to the general wish. The machinery I make use of being chiefly made of cast-iron, not heavy nor cumbersome, is both cheap and durable; and as the whole may be got in readiness, and fit to put together, before it is sent to the mill, the time lost in putting it up can seldom exceed a week or ten days; and dimensions may be sent, by post, to the patentee from any distant part, by which he can prepare his machinery, without the necessity of previously viewing the mill. The advantages arising from my invention will easily appear by contrasting it with the numerous disadvantages under which the millers at present labour. Those who occupy windmills well know the danger they are often exposed to from sudden squalls of wind, and hard gales continuing and encreasing while the sails are clothed and going, which are often incapable of outriding the storm. The shafts, if not wrung off their necks, by the frequent application of the break, are so crippled and weakened as to be rendered unfit to be trusted after repeated injuries of this kind, and various other mischiefs arise in consequence. The uncertainty of the wind, and the danger in long and dark nights, often deter the miller from grinding when he is in the greatest need; and the time and trouble necessary to stop the mill and alter the cloth so frequently in unsettled weather, are such as to disable him from doing a great proportion (perhaps half) of the work which could otherwise be done at those times. By the assistance of my machinery, all these in-

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conveniences will be wholly remedied. The miller without stopping the mill may, in six or eight seconds, unclothe the whole of the sails if necessary, or instantly so effectually relieve the sail by drawing the cloth from the thin edge towards the whip as to secure his stocks from the twisting and straining to which they are otherwise liable, and relieve the shaft from the injuries resulting from the application of the break; and thus not only will much time be saved, but also a considerable reduction be made in the expense of repairs. Besides the advantages above described of doing *safely much more work in gusty weather*; I can at a small additional expense afford the miller more power, by exposing a greater surface of cloth in *low winds* than prudence would allow him to adopt, without the constant and ready control which by this machinery he will always be able to exercise over the wind. My method of laying on the cloth, in an even breadth from top to bottom, far exceeds the common way of partly unclothing by rolling a portion of the cloth diagonally to the point of the whip, as a long and regular surface from top to bottom makes her go much more steady in strong gales and sudden squalls without so hastily feeling the effect of the wind's dying away. The firmness with which my machinery may be fixed to the shaft-head, and the few dependencies it has, in comparison of others, will, it is presumed, secure it from getting out of order, and from the heavy complaints and strong objections that have been brought against others on that account: and as I have now applied my improvement to as old a mill as most in the country, which, although the shaft-head is as crazy and rotten as can readily be met with, performs with ease and safety, I feel no hesitation to engage to put it up to *any old mill*, that is but in a working state, let the sails be as much twisted and bosomed as possible, and insure its performing its work for any given time.

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The endeavours that have been hitherto made, to make the wind generally do the work itself, has exposed the machinery to be so constantly teazed and fretted, and so liable to be out of order, so much expense has been indured and time lost in fixing it up, and so much attention required, to oil and keep it in order, as to prevent the universal application of such improvements to common windmills; but for a moderate additional charge centrifugal balls may be adapted to draining-mills in the fens with my machinery, so as to make the mill unclothe or clothe herself when she is going at a velocity *beyond* or *less* than a given speed, while at all the intermediate degrees the machinery will be constantly at rest though the mill will continue in motion. And this might be applied to windmills in general, but my improvement is on several accounts preferred by the millers without that addition.

Specification of the Patent granted to Booth Hodgetts, *of Dudley, in the County of Worcester, Nail-Ironmonger; for certain Improvements on Machinery for rolling Iron for Shanks, and forming the same into Shanks for Nails.* Dated November 8, 1803.

With a Plate.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said Booth Hodgetts do hereby declare, that my said invention of certain improvements on machinery for rolling iron for shanks, and for forming the same into shanks for nails, is particularly described and ascertained in the drawings and description thereof hereunto annexed. In witness whereof, &c.

A (Pl. III.) the inside of a mill, commonly used for rolling bars, and slitting or cutting them into rod iron. B, the shaft which

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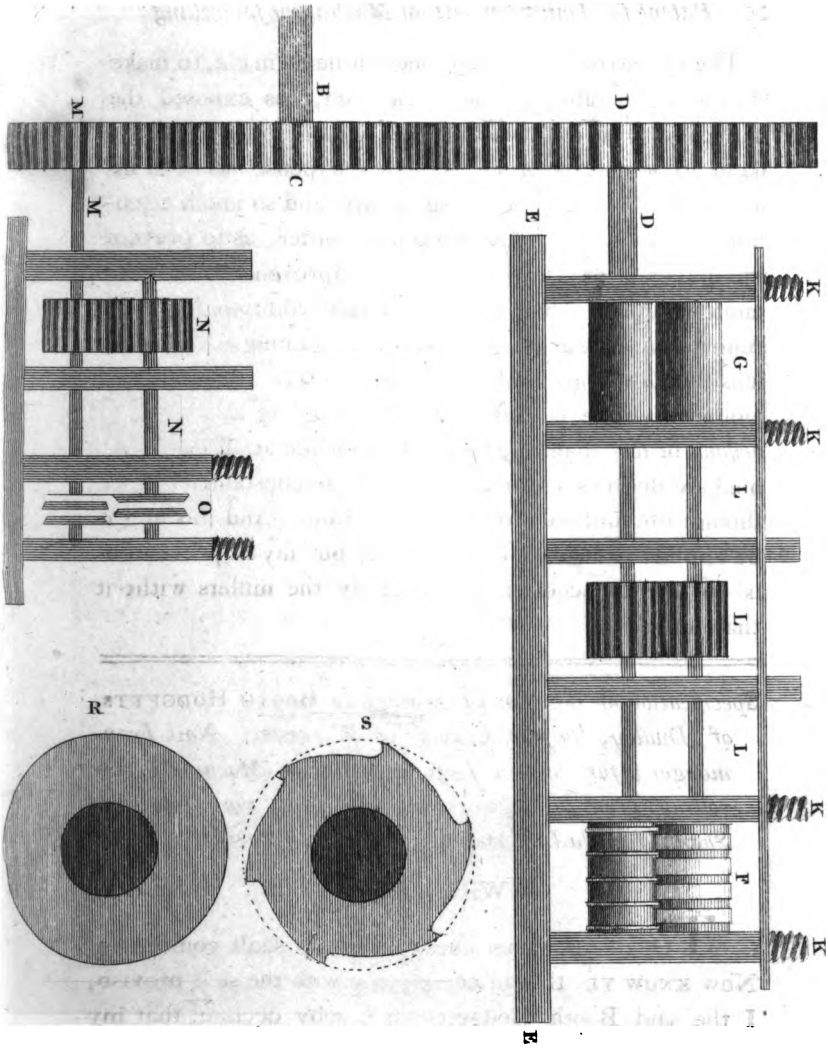

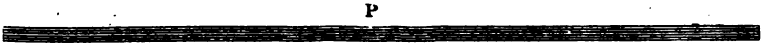

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which connects the machinery, with a wheel to be worked either by steam or water. C, the spur-wheel. D D, the wheel and shaft which work the rollers. E E, the bed which the standards are fixed upon. F, the rollers to roll blooms or slabs of iron into bars. G, the rollers to roll bars or pieces of iron to a proper thickness before they are cut or slit into rods. K K K K, the iron standards in which the rollers work, with screws to keep them at a proper distance from each other. There are four standards to each pair of rollers, though the front-view can shew only two. L L L, the pinions and connexions. M M, the wheel and shaft that work the cutters or slitters. N N, the pinions and connections. O, the slitters or cutters and the iron pillars with screws in which they work: there are four pillars, though the front-view shews only two. P, the edge of a bar of iron after it has been rolled with common rollers before it is slit into rods.

My improved way of rolling and cutting iron so as to form those parts of nails called the shanks is as follows.—A pair of rollers (which I put in motion by the machinery above described, or any other mechanical power) are thus prepared: one of them in the usual way, round, see letter R; the other roller (letter S) is cut, indented, or grooved, so as to roll a bar or piece of iron, thick and thin (see T), in proper lengths, according to the nails wanted; that is, one end of each length must be left thick enough to make the head, and then gradually tapered to the other end till thin enough to form the point. The dotted circular line shews the end-view of the roller in the form it was before cut or indented; and the black lines shew the form and manner that the grooves are cut or indented on the roller, and represent it in its improved state. The grooves may be either cut quite across the roller S from one end to the other, to make all the shanks

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of one length or sort, or may be cut in divisions so as to make different sorts or lengths. T, shew the edge of a bar of iron after it has been rolled in or between the rollers R and S, in which state it is then to be cut or slit into proper breadths in such slitters or cutters as are generally used in an iron-slitting mill. The nail-shanks are afterwards separated from each other and smoothed, and then headed in the usual manner. Brads do not require to be headed.

Account of Improvements of Boggy Land.

By BENJAMIN WADDINGTON, *Esquire, of Lanover-House, near Abergavenny, in South Wales.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal was presented by the Society to the Author for this Communication.

HAVING in the year 1798 determined to plant with larches, ashes, &c. about twelve acres of pasture-land, situated not far from my house, the soil of which is gravelly and partly boggy, and which had not been by any means productive, I ploughed it up, and obtained from it that year an indifferent crop of potatoes. It being bounded on the lower side by a brook, I had a bank thrown up; and in November, 1798, I made a willow fence, such as Dr. James Anderson has recommended in his "Essays on Agriculture," &c. &c. In March, 1799, I received from Glasgow 108,000 larches and 5000 ashes, part of them seedlings and part transplanted. I had the larches put into the ground as soon as possible, two feet apart, in rows, as recommended by Dr. Anderson, in his

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his third volume of Essays. The 5000 ashes, and 2000 more which I procured in this neighbourhood, I planted according to the judicious method recommended in Article twenty-two of the fifth volume of the "Bath Society's Papers," &c. I state it thus concisely, from not having time to describe the method more fully. A considerable number of the larches having been much injured in a long passage from Glasgow, in December, 1799, I procured 12,000 transplanted ones, to fill up vacancies; and in another part of the same ground I planted 2000 spruce firs by themselves, two feet apart, and 1000 Spanish chesnuts likewise by themselves. Part of the ground being still unoccupied, in October, 1800, I ordered from Glasgow 21,600 more larches, which arrived in February, 1801, and were immediately planted. Several of them having died in the course of that year, I procured, in December, 1801, 14,400 more, and 2,400 English or Scotch elms. The larches were made use of to fill up vacancies, and a part of the ground that was still unplanted; and the elms were put into the ground principally near the hedge-rows round the plantation, and other parts of my estate. All those that came last were transplanted trees, from one and a half to two and a half feet long; and having arrived in excellent order, they have completed the plantation, excepting about a quarter or half an acre, at present a bog, which it is my intention to cut drains through, and to plant with ashes this winter.

I have the pleasure to say, that the whole, or nearly the whole, of the larches and ashes, appear now to be in a very flourishing state, some of the former being twelve feet three inches high, and many of them ten feet. I have found the transplanted trees to thrive the

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best. The ashes are many of them six feet four inches high; and they made by far the greatest shoots this year. About half of the Spanish chesnuts are in a thriving stase, and almost all the elms. Half of the spruce firs have died; but the remainder have lately made great shoots, as have likewise about 2 or 300 oaks introduced in different places.

I am persuaded I may safely say, that there are at present no less than twelve acres of indifferent land in a fine growing state.

110 to 120,000 Larches,
6000 ——— Ashes,
2400 ——— Elms,
1000 ——— Spruce Firs,
500 ——— Spanish Chesnuts,
200 ——— Oaks.

As I was induced to make this plantation in consequence of observing a growing scarcity of timber of all descriptions in this country, owing to a large consumption by several very extensive iron-works, that have been erected within these fifteen or twenty years, I shall probably ere long plant the whole, or part of another tract of land (nearly fifty acres) which I have in an elevated situation, with larches, where I have no doubt they will flourish, and become very valuable to my children, and to the public.

Improvements

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Improvements in Pendulum-Clocks, by diminishing the Friction in Escapements.

By Mr. EDWARD MASSEY, *of Hanley, Staffordshire.*

With a Plate.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

Fifty Pounds were voted by the Society to Mr. MASSEY *for this Invention.*

HAVING for a considerable time considered a method of diminishing the friction in escapements of pendulum-clocks, which I conceive may be of great service in making better time-keepers, by relieving the pendulum from obstructions occasioned by friction in the train of wheels, and on the acting-part of the pallets, I beg leave to lay before the Society for the Encouragement of Arts, &c. two escapements, which I have no doubt will answer the purpose intended. The difficulties which I propose to diminish in clock-escapements by this invention are as follow: first, it is allowed, that when the pressure against the recoiling-escapement is diminished, as it is liable to be, from increase of friction in the wheel-work, the vibrations of the pendulum will not be performed in so short an interval. This circumstance has the contrary effect on a dead beat; for when the pressure against the locking is the greatest, the vibrations will occupy a longer interval of time; so that the vibrations of the pendulum are liable to be affected from two causes — from an increase of friction on the acting-part of the pallets, and from an increase or variation of friction in the train of wheels. These are the objects which I have bestowed great pains and expense to remove.

I beg

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I beg leave therefore to give a description of two models * of my improved escapement that accompany this letter. First, a swing wheel is made in the usual way of making it for a dead beat, except that it is not necessary to make the teeth with fine points. The pallets, instead of being fixed on the verge in the usual way, are fixed on two light detents, one on each side of the swing-wheel. The lockings are on the inclined planes of the pallets, which are pressed against the teeth of the swing-wheel by remontoiring springs, which should be under the command of the weight or main-springs, so that if an increase of friction should take place in the wheel-work, the vibrations of the pendulum will not be much affected, so long as there remains a power to raise the inclined planes. A momentum is communicated to the pendulum through these inclined planes, by two arms fixed on the verge, which come into contact with them, and unlock one on each vibration of the pendulum. Thus, suppose a momentum to have been given by the inclined plane on the right; at the same time that this takes place the wheel moves forward, and raises the inclined plane on the left, and the pendulum, having performed its oscillation to the left, receives a momentum from the inclined plane, to compensate for the loss of power which would take place during the ensuing vibration to the right, and so on alternately. The advantage in this model consists, I conceive, in diminishing the friction in the acting part of the pallets, in giving a regular certain momentum, independent of any variation which may occur in wheel-work, or on the acting part of the pallets, except during the short time of unlocking.

* Preserved in the Society's repository for public inspection.

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The second description, being a free pendulum without a verge, is as follows: the swing-wheel must be on the outside of the back plate. The pallets are formed like a pair of tongs, and are a fixture to the clock. There is a spring fixed in the upper part of the tongs, which keeps them extended against the points of the adjusting screws. The points of the tongs are pallets, with inclined planes, and have lockings, as the one above described. The tongs are made to spring from the point by which the pendulum is suspended, and by altering the adjusting screws a proper tension may be given to the spring-part of the pallets; but they must be sufficiently under the influence of the main power. I think the main power should be about one-third more than is necessary to raise the inclined plane so as to allow for an increase of friction, which may take place in the wheel-work. There must be a cross piece fixed to the pendulum, which must come into contact with two pins that are fixed in the inclined planes of the pallets, so as to unlock one on each vibration of the pendulum. Suppose the pendulum to be put in motion, and to have unlocked the inclined plane on the right; the wheel moves forward, and raises the inclined plane on the left, at which time the pendulum receives a momentum from the spring-pallet on the right, and, after performing its excursions to the left, receives a momentum, as on the right, and so on alternately. The advantage of this escapement over that above described is, that it avoids the friction of the verge and detent pivots, and during a part of the vibration the pendulum is disengaged, so that it is a free pendulum.

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References to Plate IV.

Fig. 1.—*First Method.*

A. The swing wheel.

B C. The two pallets.

D D. The detents on which the two pallets B and C are fixed.

E. One of the *remontoire* springs on the left side; another, similar to this, is on the right side of the frame, but is not shewn in the plate.

F. The verge.

G. The arms fixed on the verge, which act on the pins H I of the pallets.

K. The pendulum, fixed in the usual way on the verge.

Fig. 2.—*Second Method.*

a. The free pendulum without a verge.

b. The swing wheel on the outside of the back plate.

c d. The pallets, formed like a pair of tongs.

e. A spring, which keeps them extended against the points of the adjusting screws.

f g. The points of the pallets.

h i. The adjusting screws of the pallets.

k. The cross piece fixed to the pendulum, which piece, as the pendulum moves backwards and forwards, comes in contact with the two pins on the points of the pallets *f g*, and relieves the wheel.

The pendulum is supposed to be in motion, and the dotted lines show those parts of the machine which are hid by others.

On

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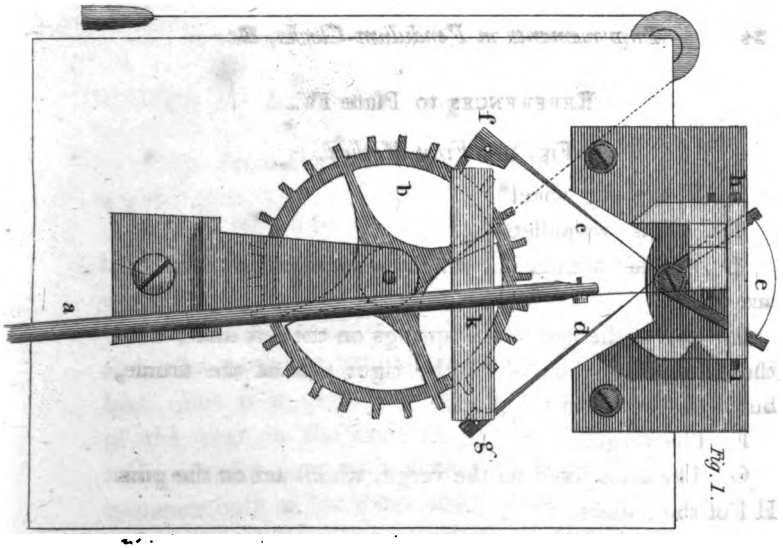

Fig. 1.

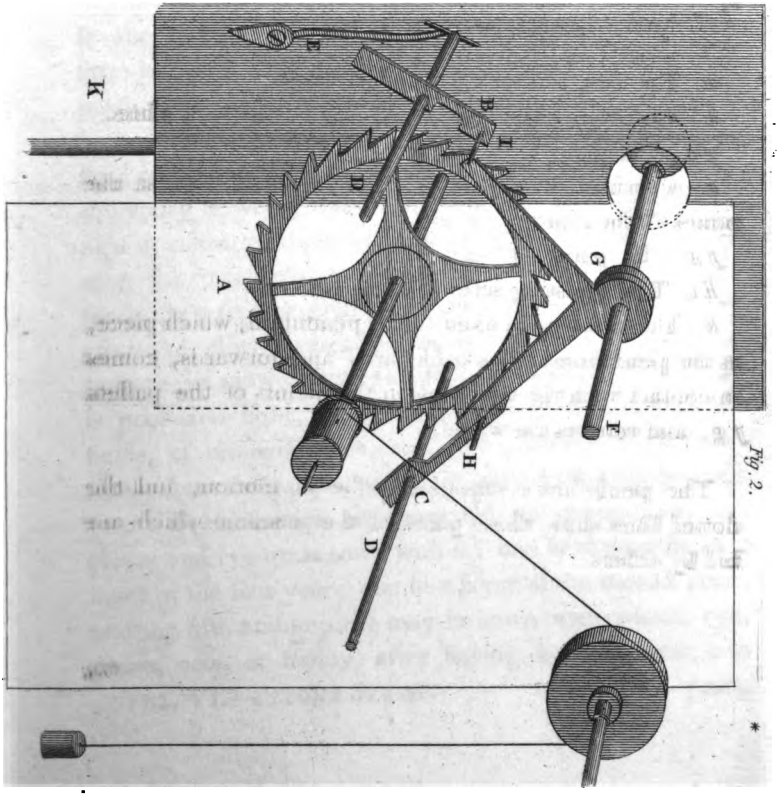

Fig. 2.

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On the Husbandry proper for a Gentleman.

From HUNTER'S GEORGICAL ESSAYS.

WITH regard to gentlemen occupying large tracts of land, unless they sacrifice all other pursuits to their farm, or be uncommonly fortunate in their choice of a steward, they will find an endless trouble in their undertaking, and most probably be glad to quit it with considerable loss. But if a gentleman spends a considerable part of the year in the country, and has a constant family establishment with occasion for some horses; the expenses both of his house and stables will be considerably reduced by the occupation of about sixty acres of good land, or one hundred acres of an inferior quality. In the first case, it would be convenient to divide his farm into four arable fields, of eight acres each, and four pastures of seven acres each. Let the arable lands be brought into a course; that there may be every year one field sown with turnips, or planted with cabbages (as the soil is dry or wet); one with spring-corn, after the turnips or cabbages; one with clover, tares, beans, or pease, after the spring-corn (the beans or pease to be kept perfectly free from weeds); and one field sown with wheat after the clover, tares, beans, or pease. And let two pastures be mowed, and two fed alternately. If the land is poor and light, it will be proper to have five arable fields, of ten acres each, and five pastures of the same size. Let one arable piece be sown with turnips each year; let the turnips be succeeded by spring-corn, and clover and rye-grass sown with it: one field must lie in a layer of the first year; one in a layer of the second year; and the fifth arable piece may be sown with wheat, rye, pease, oats, or barley, after having been a layer two

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years. And let two of the pastures be mowed in their turn, and three fed. The advantages of arranging the farm in this manner are, that the ploughed fields will produce a regular supply of summer and winter food for the cattle, and corn of different sorts with straw; the pastures will afford grass for the summer and hay for the winter; and be kept in good condition by alternately mowing and feeding. And as the preparation for the different crops upon the arable land will be at different times of the year, it may be tilled with the smallest number of cattle possible. When the fields are brought into the courses above mentioned, one pair of stout oxen will be sufficient for all the business of the farm; and as they will live upon straw, with turnips or cabbages in the winter, with a little hay at the times of sowing, and graze in the pastures during summer, they will be kept at a very moderate expense. Indeed, I think it much better to keep two oxen for that purpose than to do the business of the farm with horses occasionally used in a carriage; because, upon such a system of economy, a prudent man loses the chief convenience of his equipage, and a thoughtless one the best seasons for the work of his farm. But to occupy such a tract of land with only two working beasts, it will be necessary that the fields are contiguous; and the ploughing, harrowing, &c. must be performed in the method commonly used in Suffolk and Norfolk: and the carting of all sorts must be done with two small carts, one for each ox. The practicability of this will appear from a calculation of the time necessary for the ploughing, harrowing, and rolling, which will shew the time left for the other work of the farm. Let us take the annual tillage of the larger quantity of land. Four ploughings for ten acres of turnips, give forty acres; two ploughings for the ten acres of spring-corn, twenty acres;

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acres; and perhaps it may be advantageous to give two ploughings upon the ten acres of corn sown upon the breaking up the layer, which adds twenty acres more; and consequently there will be eighty acres to be ploughed yearly. We know, from experience, that a pair of oxen will plough six acres in a week; but, allowing for interruptions by bad weather, and other accidents, let us suppose them to plough only five acres weekly. Sixteen weeks therefore will be required for the ploughing; and, to give good allowance for the harrowing and rolling, let us add four weeks more for them; so that together they will take up twenty weeks annually; and the remaining thirty-two weeks will surely be thought sufficient for the carting, and all necessary work. Indeed, I can with more confidence assert, that a pair of good oxen will do so much, because with four oxen I occupied a farm several years, where more than twice as much labour was required; and where the difficulty was increased by great part of the arable land being so moist-bottomed, that the oxen could work upon those lands only in dry seasons.

The following may serve as a sketch of the probable expenses and returns of such a farm.

Expenses.	£.
Rent,	50
Tithe and town charges,	20
Labour,	40
Smith, wheel-wright, and collar-maker,	10
Seed-corn,	10
Interest of stock,	5
Half the expense of a dairy-maid, as she will have time to do other work,	10
Total expenses,	£. 145

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Returns.	£.
Spring-corn,	25
Corn upon the layer,	40
Grass or hay, with straw, for six horses,	60
Produce of six cows,	30
Profit of hogs and poultry,	20
Total returns,	175
Deduct expenses,	145
Profit,	£. 30

You see my estimate of the profit is not so great as that of some calculators; but perhaps it is nearer to the truth. But I cannot consider pecuniary benefit as a principal object in a plan of this kind. The advantages arising from it to a gentleman will be more material. He will find in it a pursuit very conducive to health, giving constant and interesting employment without anxiety; with something always to do, and something to expect. The succession of the various crops, and preparations for them, will furnish him with perpetual inducements to take the benefit of air and exercise upon his farm; and he will be freed from the tedious necessity of riding or walking for health's sake only. Let me add, that he who has acquired a relish for such amusements at home will have little occasion for that dissipation which is too often the recourse of those who are, by an affluent fortune, exempt from necessary attention to any profession or trade.

It may not be improper to remark, that this plan may be enlarged or contracted as required; and may often, with advantage, be partially adopted, where it cannot entirely

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entirely take place. The quantity of land may be increased or diminished according to the quantity of horses and other stock wanted by the family. Where the soil is unfavourable to the growth of common grass, it would be better to increase the tillage, and rely upon clover, tares, ray-grass, sainfoin, or lucern, both for summer grazing and a supply of hay.

Inquiries respecting the tinning of Copper, Pewter, and Pottery. By M. Proust.

From the Annales de Chimie.

Introduction.

THE doubts which have been raised for two years past respecting the wholesomeness of tinned-copper, and those to which the accidents occasioned by glazed-pottery have given birth, have already created alarm to society. Our government (the Spanish), always attentive to the removal of whatever may injure the public safety, thought it necessary to subject these doubts to chemical examination, in order that as much light as possible might be thrown upon the important question, whether tinning, by reason of the lead which is used in it, sometimes in in excess, may expose the health of mankind to the same dangers as glazed-pottery of bad quality.

In order to meet the benevolent intentions of government, it was indispensably requisite to undertake, upon the different kinds of tinning, a series of experiments, the results of which should be sufficiently conclusive to confirm the distrust which had been excited with regard to them, or to dissipate the apprehensions which had sprung from it, if they were founded upon notions merely chimerical. But these researches, such as they might have

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have been expected from a science which reckons the knowledge of metals and of their alloys among the branches of natural history which it has cultivated with the greatest attention, these luminous analyses, so ardently desired by an alarmed nation, have not yet been undertaken.

Nevertheless, it was impossible that one should have forgotten the conduct pursued many years ago, under circumstances full as critical, by the most able chemists, and particularly at the period when indiscreet clamours suddenly spread an alarm throughout all Europe, by exaggerating the dangers to which we were exposed by the use of tin, on account of the arsenic which had been discovered in it. But these useful examples were neglected, and instead of examining, as good sense required, the degree of danger which resulted from the use of lead in tinning, it was imagined that the difficulty might be removed, and the apprehensions of the public quieted, by hazarding the advice to substitute in its place another metal, which has not been sufficiently examined with respect to the effects which its solutions may produce upon the health, and which joins to this inconvenience that of dissolving with the greatest facility in the vegetable acids, and of forming with tin an alloy extremely difficult to be wrought, and very ill adapted for the tinning of copper. And what has been the result? That which might naturally have been expected from an advice founded upon an empirical receipt, extracted from a journal, which not only did not vouch for it, but which did not even answer for its accuracy, a receipt moreover condemned in all its parts by the plainest notions of chemistry and of the practice of the arts.

The difficulties which have presented themselves in the new method of tinning have discouraged the artists. These

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These difficulties being now more insurmountable than ever, on account of the want of instruction relative to this new process, have excited a multitude of complaints, which, by perpetuating the apprehensions, have caused the views of government for a time to waver, and have plunged again into the chaos of controversy as well the old method of tinning as the new one, and even the hopes which had been conceived of ameliorating either the one or the other.

The idea of alloying tin with zinc for the fabrication of kitchen utensils, and for tinning copper vessels, has been proposed long since in Europe by men of science, by artists, and by speculators; but in no country has it been founded upon any surer bases than in Spain. It has no where been ascertained by authentic experiments (which alone can convince all minds, and inspire confidence), whether the solutions of zinc, as far as regards their internal use, are so exempt from danger as has been pretended. No academy, no society of chemistry, or of medicine, has yet demonstrated in a proper manner the salubrity of these solutions. Among the persons, otherwise very well informed, who have proposed zinc alloyed with tin as very proper for tinning, and even for fabricating pewter, none has yet undertaken to ascertain, first of all, whether zinc resists better than tin, lead, iron, &c. the solvent action of the acids which exist in our aliments. In a word, some notions, taken from the historical notices which chemists have given as relative to zinc, are the only data which have seemed to authorize the recommendation to employ it for our kitchen utensils.

It is true, that if tin or its alloy could, as has been pretended, supply the place of ordinary tinning, we should have

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have reason to be surprised that Sweden, England, France, and Germany, where we have seen so many projects and demands of privileges for the exclusive employment of this metal, and where so many manufactures were abandoned as soon as established; we should have reason, I repeat it, to be surprised, that these four nations have, as it were by agreement, refused to employ zinc instead of lead, the danger of which is so well known.

Obliged by the confidence with which the government was pleased to honour me, to examine *whether zinc is or is not a proper ingredient for tinning or for pewter*, I thought it necessary to begin with some inquiries upon this subject. Although they are as yet incomplete, I have resolved to publish them, because they appear to me to be sufficient to contribute to the solution of the difficulties which have arisen upon this question, and to dissipate the apprehensions which I believe to be exaggerated. If the object of the sciences be to enlighten the arts with regard to the best and most useful employment of the productions of nature, they ought also assiduously to defend them when the speculations of intrigue or avarice endeavour to molest their peaceful laboratories, by endeavouring to compel them to modes of practice incompatible with the nature of those productions.

In order that I may omit nothing which may enable the reader to obtain a thorough information on this subject, I shall relate, as briefly as possible, the different proposals which have been made, and which have come to my knowledge, for substituting zinc in the place of lead. I shall not employ chemical terms, without explaining them in the notes, because I wish that a treatise, which necessarily concerns the interest of all classes of society, may be read and understood by every one.

1741.

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1741. Dr. Malouin was the first who, in analytical researches which he presented to the academy in 1742, and the subsequent years, published that iron and copper might be superficially whitened by means of a layer or a bath of zinc, as they were whitened by means of tin. The advantages which this author found in this new method of tinning were, 1, a hardness which prevented it from being destroyed as soon as the tin; 2, its opposing a greater resistance to liquefaction; 3, its preventing the dangerous effects of lead mixed with tin in excess. But Dr. Malouin did not deny that difficulties would occur in the practice, which would perhaps be surmounted in course of time, or which would render it necessary to abandon this process.

1742. Jean Baptiste Kemerlin presented to the Comte de Maurepas a tin of his composition, of which he would establish a manufactory, on condition that an exclusive privilege should be granted him for that purpose. Hellot and Geoffrov examined this tin by order of the Academy: they found that this alloy was far from coming up to what the author had professed concerning it; but they did not however venture to pronounce explicitly upon its composition, because the analytical processes were at that period not yet in any very advanced state.

In the same year the Academy again nominated these two chemists to examine two white alloys, adapted for making pewter, which even the historian of the Academy compared to a *similargent*, in contradistinction from *similor*, into the composition of which it had previously been ascertained that zinc entered as a constituent part.

Hellot and Geoffroy discovered this time the composition of these alloys, for they succeeded in imitating one of them, by alloying together equal parts of zinc and tin.

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But what is deserving of all the attention of the reader, is the account of the properties of one of these two alloys, which they judged to have been composed with the proportions which have just been indicated. This account describes with so much accuracy the defects of this alloy, to which it has been thought necessary to call the attention of our government, that by simply transcribing the words of the report of these academicians, I may dispense with disignating more particularly those which I have lately discovered in my laboratory with the aid of Don Pedro Blanco, a master pewterer in the street *de la Montera*,

" At the same degree of heat which affects the fusion " of good tin, this is reduced to the form of an amal- " gama, which may be cut with a knife into any number " of parts without their joining again. It does not be- " come liquid until the bottom of the iron spoon in which " the fusion is performed is made red-hot; but then a " very considerable portion of it is scorified, which as- " sumes a blue colour, and which is not reduced or re- " vived into metal, although there has been added wax " and resin, the ordinary means of restoring the parts " which have been disjoined or disguised by scorifica- " tion. Thus there would be much loss upon this metal " whenever it should be fused in order to be cast in a " mould. As it is almost impossible to give it the liquidity " requisite for *assaying it by the stone*, according to the " practice of pewterers, (explained in the History of 1741, " p. 52,) the last metal of the assays which Messrs. Ge- " offroy and Hellot have made with it, that part of the " metal which ran into the groove of the stone was ne- " ver clean and pure like it ought to be when the tin is " of a good alloy. The button which fixes itself in the " hemispherical excavation of the stone is covered at " the surface with an infinite number of needles, which

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" is always an indication of a bad tin, the old pewter of " which is hardly of any value. The same tin is also " very difficult to be cast into ingots, &c. *"

The mere reading of this description will suffice to shew how difficult it would be for the pewterers to avail themselves of this alloy, and how inconsiderate the proposal made to government has been.

Having prepared a quantity of this alloy, we found it, when fused, extremely pastey, and, as Geoffroy says, converted into a kind of amalgam, capable of being cut with a knife. The master pewterer who has been mentioned above performed this operation three times, in order to cast a vessel in a mould. At the first trial, the alloy did not run easily enough to fill it. The second was not more successful, for the piece, when he imagined that it might be taken out of the mould, fell to the ground, and was reduced into pieces entirely separate, and having no adhesion with each other. Finally, in order to have a piece well or ill cast, he was obliged to cool his mould entirely with water, and in doing this to lose a space of time which would have been sufficient for casting two of ordinary tin. This vessel of the third trial, which I have preserved, is so full of defects, that it would be difficult to remedy them by endeavouring to make them disappear by means of soldering, according to the method employed by the potters. On examining it we perceive that the last portion of the liquefied metal, during the short space of time that they run to unite to the first, lose the heat and fluidity which they require in order to solder and incorporate with them, and that consequently it is almost impossible to cast a large piece with this alloy.

* Hist. de l'Académie pour 1743, p. 108.

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But the most remarkable defect of this alloy is, that from a pound, only the piece mentioned above could be obtained, which weighs not more than nine ounces: all the rest was burnt and reduced so rapidly into scoria, whilst the piece was taking out of the mould, that it was impossible to make any use of the residue for a second fusion. If, as must naturally happen, the loss resulting from this alloy falls upon the purchaser, the pewterer will thus be obliged at least to double the price charged for each piece.

Time has also brought to light another defect in this metal, which alone would be sufficient to induce us to renounce its use.

The vessel of which we have spoken above lost entirely, in the space of a month, its original lustre; an earthy colour, interspersed with black spots, took place of its brilliancy; and now, after a lapse of six months, this vessel is as it were powdered or covered with a white efflorescence, which, when examined with a magnifying glass, clearly shews that its surface has been oxydated by the air. This circumstance demonstrates, in the most convincing manner, that this alloy has a greater tendency than any known alloy to become oxydated of itself; for this oxydation takes place in the ordinary degrees of heat of our atmosphere.

All that has been said will be rendered still more evident by comparing the vessel in question with ten other vessels which I have kept, fabricated with different alloys of lead and tin, and which have not yet lost their original lustre.

What would the working-man or the house-wife think, who should see this fine powder form upon their kitchen utensils. Should there not be reason to apprehend that some one, imbued with vulgar prejudices, the natural

fruit

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fruit of ignorance, might take this kind of flour for arsenic? Is it not enough that we employ for domestic uses two metals subject to rust, and should we wish to augment their number without any attendant utility that might compensate for this increase of expense?

Such, however, is the nature of the metal which it has been thought fit to propose to the public, as very proper to be substituted, for ordinary uses, in place of tin alloyed with lead.

But if the least reflection be bestowed upon the subject, it will be perceived that, in order to establish this innovation upon solid foundations, it would be necessary first of all to accredit it to the public, and by an instruction grounded upon well-made experiments to illustrate all the points of practice of a method entirely new to the two classes of artisans who would have to carry the projected alloy into execution. It would be requisite previously to smooth all the difficulties in order to deprive repugnance or indolence of all their pretext for opposition: it would especially be necessary, in order to convince the really or pretendedly incredulous, to demonstrate that this alloy was in no wise prejudicial to health, or contrary to the interest or the taste of that innumerable multitude of persons who might furnish the consumption.

It is only by familiarizing the public with these notions that it would be possible to dispose them to adopt this reform. Moreover, it must be evident that the proposal to abandon suddenly a metal which is already known, for another which does not appear to be so, even in the laboratories of the chemists, could not fail to give rise to serious disputes, and to the following questions, which must be started in every quarter:

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Is it demonstrated that the old alloy is prejudicial to health?

Is it demonstrated that that which is proposed is more salubrious?

Will the workmen prepare this new alloy with as much facility, and at as reasonable a rate, as the old one? and will they not be obliged, in order to accomplish it, to go through as it were a new apprenticeship?

Would it be possible to tin with this alloy like with the old one, and if insurmountable obstacles should be met with in it, would it be requisite for all the braziers of the kingdom to resort to the chemical laboratories in order there to learn the practice of this operation?

Has the new alloy as agreeable an appearance as the old one?

Is it not subject to rust, or to communicate an unpleasant taste to the aliments?

Could the pieces of this alloy be renewed or fused over again with as much facility and as little loss as those of the old one?

In case that the present utensils should become proscribed in our domestic operations, must we throw them out of the window? or have any measures been fixed upon for employing the alloy of which they are made in the arts, in order that the owners may not be too much prejudiced against relinquishing them?

All the zinc that exists in Madrid does not amount to two *arrobes**: whence is it intended to procure the requisite quantity of this metal, and when may we expect it to arrive, &c. &c.?

It is evident that prudent and reasonable chemists cannot expect that the solution of all these questions shall be furnished by the meditations of the artisan.

* The *arrobe* is 25 lbs. Castile weight.

Let

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Let us now see how this alloy comports itself in vinegar, which is the acid which we employ the most in our culinary operations. I put a plate of this alloy into a vessel filled with vinegar; on the following day the alloy had already contracted a disagreeable metallic taste. On the third day this taste, without being sweet, astringent, or bitter, had become insupportable. If we might judge of it by a metallic flavour which resembles that of the sulphate of zinc, considered in medicine as an emetic, it could hardly be doubted that half a spoonful of a metallic solution which nature has not ranked in the class of alimentary mixtures, must excite violent vomiting. A plate, having a surface of two inches, was put into vinegar, and boiled in it for the space of half an hour; and during this time the plate lost sixteen grains of its weight; whence it must be concluded, that a vessel composed of this alloy, which should present to the vinegar a foot of surface, would in a similar operation lose an ounce of its weight.

A certain quantity of vinegar was boiled in a kettle tinned with the new alloy, according to the method proposed; and this vinegar was found to have a taste as disagreeable as that of the preceding experiments.

A plate of the same alloy which was left for three days in distilled vinegar, which is much weaker than common vinegar, saturated it entirely with its bad taste. The solution was examined with the greatest attention, and not an atom of tin was found in it, because this metal is infinitely less soluble than zinc.

According to all these results, confirmed, as will appear, by the commissioners of the Academy of Sciences at Paris, it may be asserted that a metal which dissolves so easily, and which is consequently so much disposed to mix with our aliments; that a combination not less disagreeable by its taste than suspected with regard to its effects,

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effects, ought not to enter into the composition of our kitchen-utensils or into the tinning of copper, especially when nature has given us for the same uses metals exempt from danger according to general acknowledgment. We shall adduce hereafter other arguments not less cogent, which militate against the introduction of zinc into our kitchens.

1778. Doucet, author of the project of a new kind of pewter, sent in this year to the Academy of Paris, an ingot and a kettle of his metal. Macquer and Montigny were nominated to examine it. These chemists, whose knowledge in the art of analysis was far superior to that which had been possessed in the times of Geoffroy, soon discovered that the new utensils which had been so pompously announced in the public journals, as intended to expel copper from our kitchens, were nothing more than an alloy of zinc and tin. They even added that the kettles of Doucet were found to be very brittle when they were made to support the same degree of heat as is ordinarily applied in the kitchen-stoves to those of copper.

These chemists began to recognize the nature of Doucet's alloy by the bright phosphoric flame produced by its combustion; for wherever this flame is observed, it always indicates the presence of zinc. On the other hand, the application of the nitric acid by dissolving the zinc, and producing that white powder or oxyde which characterises tin, fully convinced them of the nature of the alloy *.

* When we apply this acid to the metals which it is able to dissolve, they always at first decompose it in part; they seize upon one of its principles which is termed oxygene, and they then become soluble in most of the acids.

The solution of the zinc in vinegar likewise takes place only after the oxydation of this metal, which is effected by the oxygene of the water.

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The same kettles, these academicians add, when put to heat with a little vinegar, dissolved with a remarkable effervescence, and at the same time they became covered with a white powder; phenomena which really belong to the solution of the alloy of zinc and tin. The vinegar, kept cold in these kettles, and evaporated, afforded at the end of eight days a beautiful crystallization, very white and ramified, which was nothing else than the acetate of zinc, or the combination of vinegar with its oxyde.

The same academicians mention in their report, that one Chartier had also presented to the Academy a new kitchen-utensil tinned with zinc, and that it was rejected because it was attacked by the acids and the neutral salts. They terminated their report by saying, "that the effects of the salts of zinc, taken inwardly, were not sufficiently known to enable them to pronounce them not injurious."

M. de la Folie, a man of information, and a great friend to the arts, to the progress of which he contributed much at Rouen, his native city, decided in favour of iron kettles tinned with zinc, in order, he said, to guard himself not only against the copper and the lead which corrupts the tinning, but also against the tin itself, on account of the arsenical particles which Geoffroy had suspected in it, and which Margraaf, some years before, had demonstrated to exist in most tins.

However, this combination of metals was not adopted in France, or in any part of Europe, according to the information which I have been able to collect, notwithstanding the confidence which might naturally have been inspired by the use which M. de la Folie and other individuals made of it in their own houses, and the offer which was made in the Journal de Physique to teach the

process of this tinning gratuitously to all who should apply to him for it. The apprehensions which M. de la Folie excited upon this occasion, by speaking of the arsenic contained in the tin, and which, a little time after, spread consternation through all France, were yet not able to conquer the repugnance which was felt against making use of a method of tinning, the salubrity of which did not appear to be sufficiently warranted by the example of some individuals, themselves seduced by the flattering idea of furnishing society with novelties which they conceived to be of utility.

One of the principal defects of this composition was, according to the Abbé Mongez, an impartial judge, though a friend of the author's, that it communicated heat too quickly, and required too much attention on the part of the cook to prevent the aliments from being burnt.

To these defects must be added those which Macquer has indicated, as we have shewn, in the tinning with zinc; namely, that of being too easily attacked by lemon-juice, verjuice, and vinegar, which consequently would speedily leave the iron exposed. It is known with what facility wrought iron blackens vegetable substances on account of the acid, astringent and extractive principles which they contain in greater or less quantity.

Another inconvenience, of a not less serious kind in the use of iron lined with zinc and even with tin, is that the tinning cannot be renewed without immersing the pieces in a bath of fused metal, as is done in the fabrication of white iron. Hence we may judge what a quantity of zinc it would be necessary to keep in fusion in order to line in this manner a kettle of only a foot in diameter, and how much charcoal and time would be expended upon a single operation.

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La Folie also made some experiments upon Doucet's metal. He found that the alloy of zinc and tin, in equal parts, was harder than tin and more malleable; but when he wanted to try, at a potter's, to cast some vessels, he met with difficulties which he had not foreseen, and which were probably the same as those described by Hellot and Geoffroy, and which have been confirmed by my experiments.

As to the apprehensions which were conceived in France on account of the arsenic contained in the tins of Europe, every one knows that they were soon dissipated by the work which Bayen wrote upon this subject by order of the police of Paris, and in which this excellent chemist observes that a plate of tin, which he had employed for two years at all his meals, had lost only four grains of its weight, and that the arsenic which could be contained in these four grains, detached by scouring the plate rather than introduced into the stomach, did not amount probably to $\frac{1}{5760}$ of a grain *per* day.

1802. Finally, the Journal of Arts and Manufactures has announced that the tinning with tin and zinc had lately been proposed by M. Buschendorf, of Leipzic. We shall transcribe the article for those who do not possess this journal.

"The operation is commenced with the first tinning, which is performed with fine tin in the ingot, and sal ammoniac (muriate of ammoniac) instead of resin. This first layer serves only to cover the copper uniformly, and to provide a medium for combining the tinning with this metal. As a second harder, more united and more uniform layer is to be given, it is necessary to commence with that. For this second tinning we take two parts of fine grain tin and three parts of zinc; we apply it upon the surface of the first tinning with the aid of sal ammo-

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nlac, but in such a manner that the inferior layer remains entirely covered. The addition of this semi-metal renders the tinning harder and more solid. It is then passed again and flattened under the hammer, after having previously been cleaned with chalk and water: this precaution is indispensable, in order to render the surface united and compact. The inventor of this operation has in this manner tinned several vessels within and without, in order to prevent the oxydation of the copper in all its parts; but to effect it, he strongly heated the pieces after having scraped them, and plunged them first into a bath of tin, and afterwards into an amalgam of zinc and tin, in the proportions which we have just indicated.

"There is another manner of tinning which is very durable, but more expensive, on account of the great number of metals which enter into its composition, though its durability might compensate for the greater expense. The following is the composition: one pound of fine tin, an ounce and a half of filings of malleable iron, a drachm of cast platina, twenty-four grains of mercury, and three grains of gold."

The author says afterwards, that the whole must be fused with borax and pulverized glass, formed into ingots, that these must be reduced to powder, fused again, and drawn into thin plates. All this is so laborious a preparation that we shall content ourselves with observing that such a specification is not very likely to gain credit for the happy results which the author pretends to have obtained from the first.

Let us return to his first tinning, since it is the base of that which it has been attempted latterly to introduce.

It is more durable, the author says. In order to prove this, it would have been necessary to compare pieces tinned

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tinned with fine tin with those executed according to his method.

It strengthens the copper vessels. The strokes of the hammer which must be applied to the pieces after the tinning, may strengthen them by destroying the flexibility which they have received from the fire; but this operation is attended with great inconveniences.

The first is, the necessity of separating the handles of the kettles in order to be able to pass them again under the hammer, without which this operation repeated two or three times would be sufficient to convert the circular form of their orifices into an oval.

The second is, that the pieces are rendered thinner every time they are hammered, whereby consequently their solidity and durability are diminished.

The third consists in augmenting considerably the price of the tinning; so that a kettle, the tinning of which ordinarily costs six reals, could not, according to my experiments, be hammered for less than six reals more. When the author proposes so expensive a mode of tinning, he ought at least to have demonstrated that the excess of the price would be compensated by its duration, and not to have taken it for granted that it would be believed upon his assertion.

The fourth inconvenience is, that not all kitchen-utensils are capable of supporting a second operation of the hammer, similar to that which they undergo under the hand of the workman who forms them. There are moulds destined for making ices and pastry which have not cost less than four, eight, ten, twelve, and even eighteen great piastres. Let, for example, one of these utensils be tinned, and you will see what a price the brazier will charge for smoothing it afresh, and hammering it in all its dimensions. Let the poor artisan have his choco-

late-

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late-pot tinned, which sometimes is as thin as paper: the first stroke made with the hammer, in order to flatten down the asperities, will break it all to pieces. There are, however, among the kitchen-utensils many other articles which require tinning as indispensably as those, but the tinning of which it will be impossible to execute in all their parts without exposing the owner to superfluous expenses, and having them speedily destroyed.

But, it will be said, one might tin the vessels without passing the whole of the tinning again under the hammer. I reply, that this is not possible. Give a cook one of those pots which has not passed under the hammer; it will be impossible for him to stir the spoon about to his fancy, and disgusted with such an utensil he will soon throw it aside.

It preserves the culinary vessels from the action of the acids more effectually than the ordinary tinning. It appears that the author is not very well informed with respect to the difference in the solubility of the metals.

The application of the first tinning must be begun with sal ammoniac in place of resin. Sal ammoniac is a foreign article, which is sold at present at twenty-four reals the pound, whilst resin, which is a production of the country, sells at only four quartos *. Why therefore prefer this salt to resin? It is proved that resin possesses all the advantages that can be desired for facilitating the adhesion of the tin to the copper. It is equally proved, that in the tinning of a large article the vapour of the sal ammoniac greatly incommodes the operator, whilst resin is exempt from this inconvenience.

Let a dishonest workman be authorised to employ sal ammoniac in place of resin, it will happen that when he

* Nearly half a real, or two-pence halfpenny.

shall

shall hardly have expended two quartos of salt upon a tinning which has cost him four of resin, he will raise the price of his work, without any person's being able to complain of it; for he will silence those who object to the charge, by simply telling them that the sal ammoniac costs him twenty-four reals.

Let us then not attempt to introduce into the practice of the arts ingredients both expensive and useless, and let us believe that the body of braziers, in refusing to employ sal ammoniac, have given very laudable proofs of probity and disinterestedness.

For the second tinning are to be taken two parts of tin and three parts of zinc. Pure tin, and common tin, or that which is alloyed with lead, are met with in commerce, but no pure zinc. The following is the ordinary state of this metal in Europe.

Zinc is rarely extracted in a direct way from its ores. It escapes and is spontaneously volatilized during the fusion of the ores of lead, which besides contain copper, arsenic, iron, &c. By means of the refrigeration which is provided in this operation, in the anterior part of the furnace, the condensation of a portion of zinc is effected, and it is this portion which in the form of bricks is sold in commerce, and employed in the arts; this metal, as it is volatilized, carrying away a small portion of the metals which accompany it, as I have already observed. The zinc which comes to us from Rammelsberg, from Saxony, &c. which is the only kind that is seen at present in Spain, for want of that of Alcaraz, is in this state. The Annales de Chimie are full of memoirs which prove its habitual impurity. It is true that arsenic, copper, and lead exist in this zinc only in a small quantity; but setting aside at present the arguments which an effeminate delicacy might found upon this small portion of lead, arsenic,

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arsenic, and copper, I would know from the author of the new tinning and his party, what they find so commendable in zinc, to induce them to offer it to us as the palladium of salubrity, and to propose it as a preservative against the dangerous effects of lead and copper.

Louis Patrin, a mineralogist of great reputation, says, "the German physicians prescribe zinc as a vermifuge; it is a very purgative emetic." Was Patrin, who knows Germany as well as his own house, perfectly assured of what he affirms? This I cannot take upon me to decide. Let us return to the propositions of M. Buschaendorf.

If zinc be a metal so proper for tinning, and if it must preserve us from the dangers of copper, why has the proportion indicated by the author been diminished among us? why employ it at first in equal parts, when Buschaendorf prescribes two of tin and three of zinc? why afterwards take three parts of tin to one of zinc? Does this uncertainty proceed perhaps from the circumstance that the method prescribed by the author was deemed impracticable? On this subject no doubt can be entertained.

We shall soon see whether these ameliorations facilitate the tinning with zinc. In the mean time we may take it for granted, that the new proposed method of tinning is, with a very slight difference, of the class of so many others which we find in books, and which are brought forward from time to time, and produced as arcana.

TO BE CONTINUED IN OUR NEXT.

Means

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Means of giving to red Copper the Colour, the Grain, and the Hardness of Steel. By M. Sage.

From the Journal de Physique.

Margraff and Pelletier have communicated to the public their researches respecting the union of phosphorus with different metallic substances, a process which the French chemist brought to greater perfection. By repeating and varying his experiments, I discovered that the most certain and most expeditious means of phosphorating copper, was to take this metal in the metallic form, to fuse it with two parts of animal glass and a twelfth of charcoal-powder; but it is of essential consequence that the copper present much surface, an advantage which is to be obtained by taking cuttings of this metal and placing them, layer by layer, with the animal glass mixed with charcoal-powder. I expose the crucible to a fire of sufficient activity to fuse the glass upon which phosphorus is formed, the greater part of which burns, whilst another part combines with the copper, in which it remains so incarcerated that it is not disengaged from it, although in fusion for twenty minutes under the animal glass which has not been decomposed.

When the crucible after cooling has been broken to pieces, we find under the glass, which has passed into the state of red enamel, the phosphorated copper, in the form of a grey and shining button. On weighing it the copper is found to have been augmented one-twelfth by this operation.

If the fused phosphorated copper falls upon a plate of polished iron, it extends itself in the form of strata, variously configurated, which have a chatoyant appearance, like a dove's throat.

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The phosphorated copper is much more fusible than red copper; it may often be fused under charcoal-powder without losing any of its properties.

The same phosphorated copper, when exposed for a long time under the muffle, separates from the phosphorus only with great difficulty.

The copper thus combined with phosphorus acquires the hardness of steel, and also the same grain and colour; like it, it is susceptible of the most beautiful polish; it is easily turned, and it is not altered by exposure to the air. I have kept for fifteen years in my laboratory buttons of phosphorated copper, which have not undergone any alteration. The copper does not exhale any odour when it is rubbed: if it were ductile it would be of the greatest utility, for fatty substances do not appear to have any action upon it.

In the phosphoration of the copper only a part of the animal glass was decomposed, because there was not employed a sufficient quantity of charcoal to phosphorate the whole of the acid; but it is necessary that this should be so, in order that the vitreous scoria may be sufficiently fluid for the phosphorated copper to disengage and collect itself with facility.

The deep-red enamel which is formed in this experiment may be employed with advantage for porcellain and enamelling, as this red is not altered by fire.

Copper cannot combine with phosphorus except in the dry way. If we put a cylinder of phosphorus into a solution of nitrate of copper, diluted with from four to five thousand parts of water, we find at the end of eight days the copper in a metallic, crystallized, and ductile state, forming a case round the cylinder of phosphorus.

Memoir

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Memoir on Milk and on the Lactic Acid.

By M. BOUILLON-LAGRANGE.

From the ANNALES DE CHIMIE.

§ 1. *State of our Knowledge respecting the Lactic Acid.*

THE chemists who have contributed the most to make us acquainted with the nature of milk, and its chemical composition, are Scheele, Deyeux, and Parmentier.

The experiments undertaken before these able men, belong to Hoffman, Boerhaave, Homberg, Geoffroy, Rouelle the younger, and Baumé. But the analysis of the animal substances was at their time still in so imperfect a state, that there was but little to be collected from their experiments.

The labours of Scheele were directed by very different views; his ingenious experiments led him to determine the characters and properties of an acid which is afforded by the serum of milk. Notwithstanding the labours of this celebrated chemist, something still remained to be desired respecting this substance.

"Besides the great number of its saline compounds," says M. Fourcroy, "which are still wanting to the sci-"ence, Scheele has not indicated the action of fire upon "this acid, its spontaneous alteration by the air, the "manner in which it comports itself with the nitric acid, "&c.: it is not known whether it is totally decomposed "by the latter, or converted into another acid, especi-"ally the oxalic. We are wholly ignorant of its inti-"mate nature and composition; though it presents pro-"perties which nearly resemble those of the acetous "acid, and which even lead to suppose that it is very "nearly allied to it; it is not yet possible for me to rank

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" it among the vegetable acids. On the other hand, I " am as little able to decide relative to its animal nature, " since no experiment has yet demonstrated the presence " of azote in it, and since we are ignorant whether it " can afford ammoniac in its decomposition, whether it " is putrescible, whether it can be converted into Prussic " acid, &c."

This passage, while it exhibits the state of our knowledge respecting the lactic acid, traces, as it were, the course which we have to follow in order to determine the rank which this acid ought to hold in the number of well-ascertained chemical facts.

§. 2. *On Milk and the caseous Matter.*

Before I give an account of the experiments which I have made upon this acid, I conceive it useful to premise some reflections upon milk and its constituent parts.

M. Guyton, in the *Encyclopedie Méthodique*, presents two questions upon the existence of the acid in milk. This chemist expresses himself as follows.

Does the whey exist in milk, such as it is found after the separation of the other constituent parts? Does it not exhibit acid properties only by reason of the salts which it holds in solution, as all the analyses suppose?

If the whey, adds the same chemist, existed in milk such as it is found after the separation of the butyraceous and caseous parts, nothing more would be required for re-producing milk than to mix these three principles again in the same proportions. Whence he concludes that the whey is the product of a real fermentation.

The examination of this first question, founded upon his experiments, must prove, I think, that it is not sufficient, in order to ascertain whether whey exists in milk, to re-produce milk by mixing the three principles together

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ther in the same proportions; 1, because these principles are no longer the same; 2, because, according to the process which has been followed, the whey is more or less acid.

First Experiment.

Milk recently drawn reddens the paper and tincture of turnsole.

Second Experiment.

If we distil milk in close vessels, and divide the products, the first is not acid; the second reddens turnsole, and slightly precipitates the nitrate of silver; the third has no longer any action upon the tincture. At this period the milk is not yet decomposed, it still reddens turnsole. It appears that the acid which remains is no more volatile, and that it is retained either by the animal matter or by some other substance.

Third Experiment.

If we coagulate milk with a mineral or vegetable acid, the whey is separated without retaining a particle of the acid employed.

I observe, however, that we might be under an error, if we examined only the serum obtained either by the sulphuric acid or by alum, for the precipitate which barytes gives is not entirely re-dissolved by the nitric acid. I have convinced myself that it was owing only to the decomposition of a small quantity of sulphate of potash which the serum contains: of this we have an evident proof, when we employ whey which has been separated by any other substance that is not acid.

Fourth Experiment.

If we expose milk to the air at a temperature of 12 to 20 degrees, the separation takes place in twenty-four hours.

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hours. The coagulum has a more marked acid taste than that of the third experiment. Hot water deprives it of its sour taste, and reddens turnsole.

We thus find again here nearly the same properties in the caseous matter spontaneously formed, and in that which is separated by the acids.

Fifth Experiment.

The same experiment, made with the pneumato-chemical apparatus, occasioned no absorption of air, or disengagement of any elastic fluid; only, the separation of the caseous matter was not effected till at the end of several days; one part of it swam upon the liquor, the other occupied the bottom of the vessel.

Sixth Experiment.

A bottle was filled with fresh milk, and accurately corked; at the end of some days the caseous matter was separated. As soon as the separation appeared complete, it was attempted to draw the cork, but it quitted the bottle with violence, and a whizzing sound which indicated the presence of an elastic fluid. When the bottle was shaken, a greater quantity of gas was disengaged, which, when collected and examined, presented the same characters as carbonic acid.

The liquor, as well as the coagulum, had an acid taste, very pungent, which was weakened in proportion as the carbonic acid was disengaged from it by agitation.

The liquid, after having been heated, did not appear to be more acid than the serum, which had been obtained from milk exposed during the same time to the air.

The same experiment was made with milk which had boiled about half an hour; the phenomena were the same.

Seventh

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Seventh Experiment.

The caseous matter procured from the third, fourth, and fifth experiments, differs essentially in taste and consistence.

That of No. 3 is dry and firm; that of 4 is more divided and less dry; a portion of it dissolves in water.

Finally, that obtained from Nos. 5 and 6 is not grumous; it is more light, and does not unite in a mass till at the end of several hours.

The caseous matter therefore acquires peculiar properties according to the substances and the processes employed for separating the serum.

These first experiments lead us to the following reflections.

1. That milk does not require to be decomposed in order to manifest the presence of an acid;

2. That this acid is mixed with salts, the saccharine matter, and an animal matter;

3. That the acid in the milk is free, but that this free state is not very perceptible except by the re-agents;

4. That the contact of the air is unnecessary for isolating the constituent parts of milk;

5. That the coagulating substances only facilitate the separation of the curd, either by forming a new compound, or by bringing the molecules into more immediate contact; then the caseous matter acquires new properties; or, finally, when the milk has been exposed to the air. Gradually a part of the sugar of milk is decomposed; carbonic acid is formed, a part of which is disengaged, and the other facilitates the separation of the coagulum; caloric also favours the attraction of the coagulating substances for the curd. They all act differently, for alcohol, which has also this property, produces other

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other results; the curd may, to a certain degree, be re-dissolved in water. We cannot therefore, as chemists have asserted, attribute these effects to the solution of these matters in the water, and to their having a greater attraction for this liquid than the caseous substance has.

Of this the muriate of soda, and especially the muriate of lime, affords us the proof. These salts effect the separation of the curd only in part, and yet the muriate of lime has a very great affinity for water; the decomposition ought then to be effected in a more marked manner than with the acids.

Whey is therefore not the product of a fermentation. If alcohol is obtained from milk, this does not prove that in order to obtain the lactic acid it is necessary that this formation should take place, for we may obtain the lactic acid from a serum recently prepared.

As to the formation of the carbonic acid, indicated experiment six, it is owing to the decomposition of a small quantity of animal matter, and to a part of the sugar of milk dissolved in the serum; the more that is decomposed of these substances, the more of carbonic acid is formed; also the degree of acidity is more marked by reason of the presence of the carbonic acid; but if we come to expel the acid, the serum is sweeter, and has less acidity than that which has been exposed for some time to the air.

If we expose the serum to the air for the space of ten or twelve days, in proportion as the saccharine matter is decomposed, the whey becomes more acid; these degrees of acidity are owing to a small quantity of acetic acid formed with the aid of the carbonic acid and alcohol, that has remained in the liquor, which naturally must augment the acidity of the acid already formed in the milk.

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As to the second question: does not whey manifest acid properties only by reason of the salts which it holds in solution?

I have proved that the acid might be isolated from the saline matters without exposing the milk to the air for a greater or less space of time, as Scheele has indicated; the experiments which I shall report in this memoir will furnish additional proofs. Thus its acid properties do not depend solely upon the salts which it holds in solution, and the lactic acid is not produced by a fermentation analogous to the aceteus.

Though the action of caloric upon milk is generally known, I shall however make an observation upon the acid which is obtained in distillation by naked fire, and which has for some years past been termed zoonic acid.

If we purify this acid, and combine it with potash, the result is a salt which presents all the characters of the acetate of potash.

I shall also remark, that in the caseous matter in which some chemists have not been able to find the phosphate of lime which Scheele had announced, it really exists. In order to obtain it, it is sufficient to heat this substance strongly in a crucible, after having washed it well, and to calcine to whiteness.

There remains a hard white matter, some pieces of which, veined with blue, may be compared to the Turquoise.

The nitric acid dissolves them without effervescence; lime-water and ammoniac occasion in them a flakey precipitate of phosphate of lime.

The oxalate of ammoniac also demonstrates the existence of the lime in it.

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§ 3. *On the Serum of Milk.*

Wishing to know whether there existed any differences in the wheys obtained by different substances, I employed mineral acids, some vegetable acids, salts, such as alum, the acidulous tartrite of potash, &c. The coagulating matter was employed with the proper precaution, having remarked that when an excess of acid was used, it was found again in the serum, whereas when only the necessary quantity is added, the cheese alone seizes it.

After the caseous matter had been separated, the serums were clarified; the wheys had all the same taste and the same colour, and indicated the same degree of acidity.

If fresh whey turns the syrup of violets green, this property must be attributed only to the union of the yellow and the blue, not to the saline matters, as chemists have asserted; whey which has lost its colour, by exposure to the air, reddens the syrup of violets.

The means employed for ascertaining the presence of the acids which had served for coagulating the milk, could not discover the smallest quantity of them, especially, I repeat it, when the operation has been performed with accuracy.

I tried, by way of comparison, serum which had soured in the air, and obtained by exposure of the milk; the phenomena which I have indicated § 2, experiment 3, were precisely the same.

The following are the circumstances in which the spontaneous serum differs: 1, its taste is more acid; 2, its colour is dull and whitish, owing to white filaments, which separate themselves from it. By filtrating we may obtain it clear, but it never has the colour of fresh whey.

The

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The caseous matter resulting from the different experiments mentioned above, gave the same red with the tincture of turnsole; if we calcine and treat it, we may, by the known re-agents, demonstrate the presence of the sulphuric acid in it, if this acid has been employed for coagulating, and of alumine, if alum has been used, &c.

I do not see therefore any inconvenience which can arise to the preparation of whey for pharmaceutical uses, from coagulating the milk with either of the above-mentioned substances, especially with the precautions which I have indicated; those who have supposed it to be prejudicial to health to coagulate with alum, had no doubt made no experiments on the subject.

The action of lime-water, of the solution of barytes, of strontian, and of some metallic salts, although already known to chemists, deserved to be examined anew; it will soon serve me for the explanation of the processes for obtaining the lactic acid.

§ 4. *Of the Sugar of Milk.*

The formation of the acetic acid is not owing merely to the alteration of the sugar of milk; and though the experiments which I have already quoted allowed me some conjectures, I have ascertained whether one might obtain an equal quantity of sugar of milk from fresh serum and from serum which had been exposed for twelve days to the air, and to a temperature varying from fourteen to twenty degrees.

I found that the soured milk afforded a little less sugar of milk, which proves that a portion of the saccharine matter has served for the formation of a quantity of acetic acid.

We may therefore obtain the carbonic acid, the alcohol and the acetic acid, both in close vessels, and when the whey remains exposed to the air.

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Other experiments made upon the pure sugar of milk presented to me nothing remarkable.

It does not redden the tincture of turnsole. Dissolved in water, and exposed for a long time to the air, it does not turn acid. In distillation it gives, besides the known products, acetic acid.

It dissolves in the weak acetic acid; if we add a small quantity of fresh caseous matter, we soon perceive that the liquor holds some of it in solution, by pouring in some drops of alkali, in order to saturate the excess of acid; from being transparent it becomes turbid, milky; it has a sweet taste, analogous to that of milk, and it preserves for a considerable length of time its opacity.

From the facts indicated in these four sections it results:

1. That milk newly drawn reddens the tincture of turnsole;

2. That we may separare the caseous matter from it without the contact of the air;

3. That the serum does not retain the acids which have been employed to coagulate the milk;

4. That the distillation of milk to dryness, and that of the sugar of milk, give acetic acid;

5. That the formation of the carbonic acid and of the alcohol is owing merely to the mucoso-saccharine matter.

6. That a quantity of acetic acid is formed by the fermentation of these substances;

7. That the caseous matter, when it has just been separated, always manifests the presence of an acid, and that it differs in taste and consistence, according to the matters which have been employed for separating it?

8. That when well washed, and giving no indication of acidity, diluted afterwards in distilled water, at the end of some days, and in a temperature between fifteen and

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and twenty-two degrees, it acquires a strong disagreeable smell; the water slightly reddens turnsole; lime disengages ammoniac from it;

9. That the serum and the caseous matter contain, besides the known substances, phosphate of lime, as Scheele had announced;

10. That the difference which exists between fresh serum and that which has been exposed to the air, consists in the circumstance that there is acetic acid added to the acid which is free in the milk;

11. Finally, that there exists in milk and in the serum a free acid, which has appeared to me to be acetic acid.

§ 5. *On the Lactic Acid.*

Scheele having discovered that it was not possible to obtain the acid by a simple distillation, had recourse to particular means for effecting this separation.

This chemist first reduced the whey to an eighth by evaporation; he filtrated it, and there remained, he asserts, no more caseous parts in it.

He saturated the liquor with lime-water, and the phosphate of lime was precipitated. This liquor having been filtrated and diluted with thrice the quantity of water, he poured into it oxalic acid by drops, in order to take up again and precipitate all the lime; he convinced himself by the addition of a little lime, that there remained no oxalic acid in it. He then evaporated the liquor to the consistence of honey; the inspissated acid was dissolved again in rectified alcohol; the sugar of milk, and all the other substances foreign to the acid, which had not been dissolved by the alcohol, remained upon the filtre. Finally, after having again added a little water to the acid held in solution by the alcohol, he caused the latter

to

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to pass off by distillation, and he found in the retort the lactic acid.

This very long and expensive process does not yield a pure acid. It was therefore necessary, previous to examining its nature, to seek a more simple process.

First Experiment.

If, instead of exposing the whey to the air, as Scheele indicates, we perform the process immediately, we obtain only a very small quantity of acid less coloured, and of a more animal smell.

This acid has appeared to me to be that which is found free in the milk, on account of the small quantity obtained.

Second Experiment.

Instead of employing lime-water and oxalic acid, I used barytes or strontian and sulphuric acid; and I obtained an acid as pure as by the process of the Swedish chemist.

Third Experiment.

I had also tried the acetate of lead in order to decompose a lactate of potash, expecting to form a lactate of lead decomposable by sulphuric acid; but the precipitate which is formed is not a lactate of lead, for when we add the sufficient quantity of sulphuric acid with the intention of decomposing, we render no acid free. It appears that a part of the oxyde is precipitated with animal matter; this compound is even a little soluble; besides the liquor always retains much acetate of lead in distillation.

Thus, though this process has been indicated as superior to that of Scheele, it is certain that it cannot be employed for obtaining the lactic acid. The experiments which follow have been made upon the lactic acid of Scheele.

1. We

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1. We may diminish the intensity of its colour by triturating red-hot charcoal in a mortar, and pouring lactic acid upon it; a quantity of small flakes are separated, which rise to the surface. It was slightly boiled and filtrated; the acid was then less coloured and less odorous.

2. When we distil this acid in a retort, acetic acid passes over, and a thick, yellow, very acid matter is left behind.

It might perhaps be thought that a part of this acid is changed into acetic acid with the aid of the caloric, as M. Berthollet observes. (Statique Chimique.)

"The ternary acids," says this chemist, "may be changed into acetic acid, when, by the action of heat, they abandon a part of their carbon, and their elements, which resist this action less, are separated and volatilized."

I have convinced myself that a great part of this acid existed in it before.

3. The same phenomena take place, but in a more marked degree, if we distil whey which has been exposed to the air to a temperature from fifteen to twenty degrees, during the space of about fifteen days. The first product is a clear transparent liquor, of an acid taste and an alcoholic smell, which, combined with potash, forms an acetate. If we add alcohol to what has remained in the retort, it becomes coloured; when it has been decanted and distilled, we find in the retort an acid of a peculiar animalized smell, similar to the preceding; but the acid contains a very small quantity of phosphate of lime.

These experiments come in support of the observations which I have made, 1, that we obtain by the process of Scheele a mixed acid, 2, that an acid exists in whey newly prepared. We must now endeavour to ascertain the nature of this acid.

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For this purpose I prepared lactic acid according to the process of Scheele, with all the requisite precaution. I even assured myself previously of the purity of my alcohol; distilled upon muriate of lime, it marked forty degrees by Reaumur's areometer.

The lactic acid dissolved in the alcohol was subjected to distillation. There passed into the receiver an alcohol which reddened the tincture of turnsole.

When the acid was totally freed from the alcohol, the distillation was discontinued. There remained in the retort Scheele's lactic acid, of a yellow colour, and a very acid taste.

First Experiment.

I mixed quick-lime with this concentrated acid. Ammoniac was disengaged *.

Second Experiment.

If we form a lactate of potash, and evaporate it with a gentle heat, there is separated a brown matter, insoluble in water; heated afterwards in a crucible, the salt swells up, and diffuses an animal odour. The presence of the prussic acid has been proved by dissolving the remaining matter in water, and adding to it a little solution of sulphate of iron.

Third Experiment.

If we add sulphuric acid to lactic acid, or to a lactate of potash, not only a disengagement of acetic acid takes place, but also an elastic fluid, which forms a thick cloud when it is in contact with ammoniac.

* I had already ascertained the presence of azote in this acid; I announced it the 18th Nivose to the Society of Pharmacy; M. Vauquelin, who did not know it, told me at the reading of the first part of this memoir, that he had also recognized the presence of an animal matter in the lactic acid of Scheele.

Fourth

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Fourth Experiment.

When we distil the above mixture in an apparatus adapted for receiving the gaseous product into water, the distilled water of the flask preserves its transparency; the odour of the acetic acid is strongly marked; it reddens turnsole, and precipitates the nitrate of silver.

Moreover, a small quantity of ammoniac was approached to the tube from which the gas was disengaged, and a very thick cloud was formed.

Fifth Experiment.

What remained in the retort was evaporated to dryness; a very acid brown matter was obtained, which, when heated afterwards in a crucible of platina, swelled up, and left a coal, which was incinerated.

During this operation a small quantity of sulphuric acid was decomposed.

The matter which remained in the crucible was dissolved in distilled water. The solution did not redden turnsole, but it gave a brown tinge to paper stained with curcuma; sulphuric acid was added to saturation, evaporation was performed, and by cooling, crystals were obtained which presented all the characters of the sulphate of potash.

As the supernatant liquor had a metallic taste, prussiate of lime was poured to it, which produced a blueish tinge.

The infusion of galls caused it to pass into a brown.

Sixth Experiment.

We may still evaporate the lactic acid to dryness, heat it in the crucible to incineration, dissolve it then in distilled water, and precipitate it by the nitrate of silver. There is formed a muriate of silver, which we separate

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by the filter; the liquor which contains the nitrate is evaporated, and it is decomposed by fire. There remains a white matter, which, dissolved in water, gives with the tartarous acid an acidulous tartrite of potash.

I conclude that the lactic acid of Scheele is composed of

Acetic acid;

Muriate of potash;

A little iron, perhaps, held in solution by the acetic acid; and

An animal matter.

Analysis and Decomposition of a Liquor employed for rendering Cloth impermeable to Water.

By M. VAUQUELIN.

From the BULLETIN DES SCIENCES.

IT is well known that for several years past different persons have successfully occupied themselves with rendering cloth impermeable to water: an object of great importance for the equipment of sea and land forces.

The inventors of this process have hitherto kept the means which they employ secret; there was only reason to suspect that some fat oil formed the basis of their applications, but it has not yet been demonstrated by experiment.

A bottle of this liquor, the efficacy of which was ascertained, having fallen accidentally into my hands, excited in me the desire of investigating its composition; but before I give an account of the method which I followed for that purpose, I shall describe its physical properties.

It is a white, milky, opaque liquor, having a bitter taste, and a smell of soap: it presents, like milk, a kind of

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of cream at its surface, and it strongly reddens the tincture of turnsole. I imagined, according to these properties, that it was merely a solution of soap, the taste and smell of which it still retained, which had been decomposed by an acid; but further experiment soon shewed me that there was something else in it.

Experiment I.

In order to know whether I could separate by filtration the white matter which rendered the liquor turbid, I put a certain quantity of it upon *papier Joseph*; it passed for a long time turbid and milky; but by pouring it several times upon the same filter, I at length obtained it as clear as water; after which I tried separately the liquor and the matter which had been left upon the filter.

Experiment II.

If my conjecture had any foundation, I ought to have found in this liquor only the base of the soap united to the acid, of which there was a superabundance in it. My first care was to ascertain the nature of the acid; and what the taste had already nearly indicated to me was confirmed by the muriate of barytes, which produced in it an abundant precipitate that was insoluble in nitric acid: thus I was already assured that this liquor contained sulphuric acid; but, on the other hand, ammoniac having formed in this liquor a white flakey semi-transparent precipitate, I saw that there was something else in it than the salt resulting from a decomposition of soap.

Experiment III.

I then precipitated a certain quantity of this liquor; I washed the matter and dried it. As it had all the physical characters of alumine, I combined it with sulphuric acid; I added to it a little sulphate of potash, and I obtained,

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by a slow evaporation, very fine alum. Thus we have already in this liquor sulphuric acid and alumine undoubtedly united to each other in the state of alum.

Experiment IV.

It was now necessary to ascertain whether the liquor from which I had separated the alumine did not still contain some other substance; and first I subjected it to some trials by the re-agents, among which the oxygenated muriatic acid and the infusion of galls discovered to me a new substance in it. The first rendered the liquor milky, and soon after produced white flakes in it; the second produced yellowish white flakes, in much greater abundance than those which proceeded from the effect of the muriatic acid. I then suspected that this liquor contained, besides the matters already mentioned, an animal substance, particularly gelatine.

Experiment V.

In order better to ascertain the nature of this substance, I evaporated the liquor to dryness with a gentle heat. I obtained a yellowish salt, of a bitter taste, which, when dissolved again in water, left a yellow matter, in the form of pretty voluminous and very gluey flakes, which as they dried assumed a kind of elasticity. This substance, put upon burning coals, swelled up, exhaling white fumes which had the odour of ammoniac, and of the fetid oil which the animal matters generally yield.

I was now convinced that a certain quantity of animal gelatine had been put into this composition, with the intention, no doubt, by giving more viscosity to the liquor, to hold the oily parts for a longer time, and more completely in suspension. It is probably by the effect of heat, and perhaps by a commencement of decomposition, that the animal gelatine has become insoluble in water; but

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but I perceived that the liquor, in which the salt was, still retained some of it in solution, for muriatic acid and the infusion of galls still formed precipitates in it, only less abundant than the first time.

Experiment VI.

By this experiment I endeavoured to ascertain the nature of the fatty matter which had been left upon the filter, and of which I have spoken above; my design was especially to know whether it did not hold some other substance in combination.

For this purpose I burnt it with the filter in a crucible of platina: it exhaled a vapour similar to that of tallow or the oils; it left a cinder, of which the filter had furnished a part, and in which I again discovered the presence of a small quantity of alumine, which can be attributed only to the oil; for the *papier Joseph* did not contain an atom of it. I believe even that this oil contained also, with the alumine, a small quantity of animal matter, but this I could not positively ascertain.

Thus, notwithstanding the excess of acid which existed in the liquor, the oil, in its precipitation, carried along with it, and retained in combination, alumine, and probably animal gelatine.

The substance, therefore, which, by uniting with the cloth, renders it impermeable to water, is not merely oil, but a combination of this matter with alumine, and probably with animal gelatine, which must render this property more durable.

Experiment VII.

The liquor which I successively deprived of oil, of alumine, and in part of animal matter, by the different means above indicated, yielded me, by a slow evaporation

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ration, crystals of salt composed of soda and of sulphate of potash.

Experiment VIII.

I performed the analysis of this liquor better by another process, which I shall relate here but very briefly.

I precipitated the alumine and the oil by means of lime-water; I united, washed, and calcined the deposit; what remained in the crucible was alumine and lime.

The liquor from which these matters had been separated, being evaporated to a certain degree, yielded sulphate of lime, a certain quantity of animal matter which had become insoluble by the desiccation of the liquor; finally, sulphate of soda and potash containing still animal gelatine, insoluble in water.

The following is the manner in which I conceive that this liquor has been prepared, *the proportions excepted.* Soap and glue, or any other gelatine, were dissolved in water; with the solution of these substances was mixed a solution of alum, which formed in the mixture, by being decomposed, a flakey precipitate, composed of oil, of alumine, and of animal matter; then weak sulphuric acid was added, in order to re-dissolve a part of the alumine, to render the precipitate lighter, and to prevent its being deposited; but the alumine, having been once combined with the oil and the animal matter, no more dissolves again entirely in the sulphuric acid, and it is on this account that the oil remains always very opaque, and neither rises nor is precipitated. It is evident that we must not add too large a quantity of sulphuric acid. I do not know whether this be precisely the manner in which the operation is performed; I only know, that by following this method I have succeeded in composing a perfectly similar liquor, which possesses the same properties.

On

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On the Decomposition of the alkaline Sulphurets by the Oxydes of Lead and of Manganese. By M. Dizé.

From Van Mons's Journal de Chimie, et de Physique.

If we mix charcoal with an alkaline sulphate, and expose the mixture to a high temperature, the oxygene, which is a constituent part of the acid, burns the charcoal, and abandons the sulphur which served as its radical; but the alkali combines with the sulphur, and forms what is called an alkaline sulphuret.

This combination of the sulphur with the alkali, which is a result of the decomposition of the alkaline sulphates by the charcoal, is not so easy to be destroyed as might be imagined, especially when we operate upon pretty large masses. The frequently repeated exposure of the alkaline sulphurets to a managed heat, is not sufficient to cause the volatilization of the sulphur; the alkali retains enough of it to render it improper for certain operations in the arts; besides, the sulphur, in being volatilized, burns in part, and forms sulphurous acid, which combines with the alkali. The operation, instead of being simplified, is rendered more complicated, since we obtain only an alkali mixed with sulphuret and alkaline sulphite.

The addition of the carbonate of lime to the mixture of charcoal and of an alkaline sulphate, as it was practised in the first manufactory of soda, established at St. Denys, near Paris, was not an expensive means of facilitating pretty speedily the decomposition of the sulphuret of soda which was the result of the sulphate of soda, decomposed by the charcoal; nevertheless the soda appeared still to be mixed with sulphuret and with sulphite of

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of soda, which were easily distinguished by the smell, and in the crystallization of the salt of soda. The mixture of iron in place of carbonate of lime, or these two substances employed in conjunction, did not give a better result. The whole of the alkali could not be obtained in a pure state till after repeated washings, calcinations, and crystallizations.

Such is still the state of our knowledge of the means of purifying in the large way, and without incurring too great an expense, the alkalies which may be prepared by the decomposition of the alkaline sulphates.

These difficulties which appear of little consequence in the operations of the laboratory become very embarrassing in large manufactories, where the results ought to be equally speedy and easy to be obtained.

I shall speak in preference of the sulphuret of soda proceeding from the decomposition of the sulphate of soda by the process employed in the manufactory of St. Denys, near Paris, and which was published at the time by order of government. This process is still the most simple and most easy to be executed in the large way; at least it has been judged so according to experience. I believe that the result of my researches upon the decomposition of the sulphurets must add to its perfection, and afford some indication of which use may be made in analogous operations.

Without entering into the details of all the experiments which have led me to this improvement, I shall now state the means which I employ for decomposing the alkaline sulphurets, or freeing the soda from the last portions of sulphuret and alkaline sulphite which it contains.

After having proceeded to the decomposition of the sulphate of soda, by the mixture of charcoal and carbonate

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nate of lime, we lixiviate the crude soda, in order to extract the alkali from it. This lixivium is commonly of a yellowish colour, and exhales the odour of sulphur; if we mix with it some drops of diluted sulphuric acid, sulphur is precipitated, and hydro-sulphurated gas and sulphurous acid are disengaged with violence.

Were we afterwards to evaporate and crystallize this lixivium, we should obtain crystals of soda, from which diluted sulphuric acid would disengage hydro-sulphuret and sulphurous acid. The rest of the liquor would give soda less pure than the first crystallization.

In order to purify this lixivium, and free the alkali from the sulphur which it contains in solution, and cause the sulphite to disappear, I add to the ley, while it is in ebullition, a sufficient quantity of well pulverised semi-vitreous oxyde of lead. This oxyde separates the sulphur from the alkali, and forms by its combination an insoluble sulphuret of lead; the sulphite disappears and is converted into sulphate. The semi-vitreous oxyde of lead loses its red colour, and assumes a deep chesnut or blackish hue, by reason of the quantity of sulphur which the alkali contains. The liquor or lixivium becomes as clear as pure water; the dilute sulphuric acid disengages from it only carbonic acid gas, and forms no precipitate; in a word, this lixivium precipitates the nitrate of lead in a white state, and the sulphate of copper is a beautiful green, whilst, previous to the addition of the semi-vitreous oxyde of lead, the same lixivium precipitated these two metals of a very dark chesnut colour, that is to say, in the state of sulphuret.

Thus the semi-vitreous oxyde of lead, in the humid way, carries off the sulphur from the alkali of the soda, and may serve for purifying in the large way, and in a very easy manner, the soda proceeding from the decomposition of the sulphate of soda.

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After my experiments, and the calculations of the expence which the semi-vitreous oxyde of lead, which I had first employed, might occasion, I have substituted for it, with the same success, the oxyde of manganese, well pulverized. The oxyde of manganese, which is less costly, presents also a valuable advantage, namely, that it may serve several times for the same operation, after it has been freed from the sulphur by calcination.

This facility of separating, by the humid way, the sulphur from the alkali of the soda, without however engaging it in a new combination, that is to say, leaving it isolated and dissolved in the liquid, induced me to make use of this means for decomposing the sulphuret of barytes, and my attempt was not without success.

Decomposition of the Sulphuret of Barytes.

Generally, in order to obtain barytes in a caustic state, the sulphate of barytes is decomposed with charcoal, from which first operation results a sulphuret of barytes soluble in water; then this sulphuret is decomposed with nitric acid; distillation separates the nitric acid from the barytes, and this alkali remains pure and fixed at the bottom of the retort. This process is extremely expensive, on account of the large quantity of nitric acid which one is obliged to employ. Barytes will certainly become a very valuable substance for the arts, when we shall be able to procure it at a reasonable price.

The following is the most simple and the most economical means which I have discovered, and which I had a long time practised for my own use.

When the sulphuret of barytes is made by the decomposition of the sulphate of barytes and charcoal, I dissolve it in water; after having let it settle and clear itself, I decant it into a vessel, in which I boil it, adding to it pulverized

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pulverized oxyde of manganese, till the liquor has lost its yellow colour, and is become clear and limpid.

In proportion as the oxyde of manganese separates the sulphur from the barytes, the odour of sulphur diminishes, and instead of it an alkaline odour is perceived; the taste of the liquor, when all the sulphur is combined with the manganese, has a considerable degree of causticity; as soon as it cools, if we have not employed too much water for the solution of the sulphuret, the barytes crystallizes round the vessel.

The nitrate of lead and the sulphate of copper are precipitated from their solvents by the caustic barytes, the first in a white, and the second in a blue form; thus the oxyde of manganese has a stronger affinity with sulphur than the alkali of the soda and caustic barytes, since this oxyde, at the mere degree of ebullition, decomposes these alkaline sulphurets completely. This process appeared to me simple enough to be applied to the preparation of these two alkalies upon a large scale, so as to afford them at a reasonable expense to the arts in which they may be used.

Since the time when I perceived that the oxyde of manganese attracted, in the humid way, the sulphur from the fixed alkalies and from barytes, this means has been a great assistance to me in getting rid of the alkaline sulphurets in many analytical operations, in which the presence of the alkaline sulphuret embarrassed me, without my requiring an acid to decompose it.

The soda and the barytes prepared by this process are very pure, and come to a very moderate expense, especially the barytes.

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Of the mathematical Law of the Propagation of Heat.

From the BULLETIN DES SCIENCES.

IF heat passes from a body to be communicated to those which surround it, what portion will each of these receive? what relation will there be between their respective distances and the degree of their calefaction?

Count Rumford and M. Biot have occupied themselves with this question; but as they have arrived nearly at the same result, we shall record here only the experiments of the latter, which are remarkable for their simplicity and their fertility of application. He immersed the bent extremity of a bar of iron into a constantly uniform source of heat. Such a one is easily obtained, for it is known that as long as a body is melting or boiling, it preserves the same temperature. M. Biot therefore employed successively boiling water and mercury, tin and lead, in the act of fusion, &c. Placing afterwards thermometers into holes made in the bar, at equal intervals, causing the ambient air to act equally upon all, and waiting till they had all risen to the point at which they were to stop, he examined their respective heights.

In order now to foresee what must happen, it is sufficient to admit this principle, that the quantity of heat, which a hot body communicates to a cold one in a very short time, is proportional to their difference.

Thus we easily conceive, and the detailed calculation demonstrates it, that the different points of the bar must be by so much the colder as they are more remote from the source of the heat, and that their different temperatures will represent a descending geometrical progression, the

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the first term of which will be the temperature of the source, and which will descend the more rapidly in proportion as the nature of the bar is less adapted for the propagation of heat.

To this is superadded the refrigerating action of the surrounding bodies; but supposing the bar to be as much isolated as possible, the air of itself tends to cool it; and as, according to the principle admitted, it acts upon every point proportionately to the difference of its temperature from that of this point, what it takes away from all these points is likewise in geometrical progression; and consequently what they retain is still so.

If therefore, with an equal heat of the source, we place thermometers at determinate distances upon one and the same bar, and we know the height of one, we shall be able to calculate that of all the others, by having regard to their distance from the source.

This is what M. Biot has tried; and he has always found that the real heights corresponded to the calculated heights within a very trifling matter.

Hereby he has not only given the proof of the truth of the principle from which he set out, but he has also deduced from it a very useful application. In order to measure very high degrees of heat, it does not require an instrument adapted for being immersed in those degrees; it is sufficient to expose to them the extremity of a graduated metallic bar, and to apply thermometers to some determinate points of its length: we may then easily calculate the temperature of the heated extremity, and if we multiply the number of thermometers, and employ successively bars of several sorts, the common result of all these observations is susceptible of the most rigorous precision.

We

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We also see why a bar of iron, only six feet in length, can never be sensibly heated at the one extremity by plunging the other into any heat whatever; it is because the geometrical progression of temperatures which belongs to iron, and which depends upon the conductibility of this metal, descends too rapidly for that purpose.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

Breeding Sheep.

A FARMER at Warcot, in Yorkshire, produced this year from twenty-four ewes seventy lambs, *viz.* twenty-two ewes produced three lambs each, and one ewe four lambs; the lambs in good health and strong. The increase was supposed to have arisen from having turned the ewes into rape prior to the ram being turned to them.

Weeding Machine.

The Rev. T. Brown, of Connington, near St. Ive's, offers to all agriculturists an implement which he thinks is of the utmost importance, and worthy the notice of those persons who are desirous of cleansing their land from every kind of weed. It will work upon any soil, but more particularly upon light, and it has been used, and that continually, upon the heaviest. It is worked by either two, three, or four horses, according to the roughness of the tillage, and will raise upon bean-stubble on the strongest soil sufficient tilth in a mild season to harrow wheat in, without any previous ploughing. It requires only one person to attend it, and that is the driver, as it will keep steady to its work by itself. By employing

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ing two sets of horses it will clean from six to eight acres each day. — This implement is to be regulated (so as to cut any depth) with the greatest ease. — As a proof of the utility of this implement, the possessor had last year a very foul fallow field, thistles nearly as high as his knees: having ploughed this fallow once, the cleanser was made use of every time there appeared any sort of weed upon the land, to the amount of fifty acres; which lot of land is now wheat, and has been weeded twice over this year, and has cost the occupier 11*s.* 7½*d.* the whole fifty acres. — The last year was the first time of the Rev. Mr. Brown's making use of this implement. — The price of this machine with wheels twenty guineas, without wheels sixteen guineas.

Tanning.

M. Hermbstädt, of Berlin, has discovered that the *Tormentilla erecta*, a plant which grows almost every where, and the *Polygonum bistorta*, furnish excellent materials for tanning leather. If, for instance, a pound of dry hide requires seven pounds of oak-bark to tan it completely, the same weight of hide requires only a pound and a half of Tormentilla, or three pounds of Bistorta. He likewise employs the leaves of the oak-tree with advantage in the operation of tanning-leather.

Hydraulic Machine.

M. Trouville has made a new hydraulic machine, which throws up water to a great height without any other mechanism, and solely by the rarefaction of the air in air-tight stone chambers, placed one above another. For this invention he has been presented with a gratuity of 15,000 livres by the Board for the Encouragement of Arts and Sciences at Paris.

List

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List of Patents for Inventions, &c.

(Continued from Vol. V. Page 464.)

ROBERT FRITH, of Broughton, in the county of Lancaster, Dyer; for a method of dyeing cotton-wool, cotton-twist, cotton-weft, and cotton-cloth of a nankeen colour and of a buff colour. Dated October 3, 1804.

THOMAS PORTHOUSE, of Hall Garth, in the parish of Haughtoule Skern, in the county of Durham, Flax-spinner; for a machine for hackling flax and hemp, and at the same time carding the tow. Dated October 6, 1804.

JAMES CALDWELL, of Hathern, in the county of Leicester, Frame-smith, and JOHN HEATHCOTE, late of the town and county of Nottingham, but now of Hathern aforesaid, Frame-setter-up; for machinery and apparatus to be attached or annexed to certain frames or machines called or known by the name of warp-frames, whereby these frames will work, make, or manufacture all kinds of thread-lace. Dated October 17, 1804.

SAMUEL BENNETT, of Sheffield, in the county of York, Cutler; for a mode of making or casting razors in a new and improved form. Dated October 20, 1804.

THOMAS NOON, of Burton-upon-Trent, in the county of Stafford, Watch-maker; for a thrashing machine with loose beaters. Dated October 30, 1804.

JACOB BUFFINGTON, of the city of Bristol, Gentleman; for a method of straining or stretching (technically called habiting) all kinds of woollen-cloth for cropping or shearing, and for straining all other kinds of piece goods. Dated October 30, 1804.

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THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. XXXII. SECOND SERIES. Jan. 1805.

Specification of the Patent granted to THOMAS NOON, *of Burton-upon-Trent, in the County of Stafford, Watch-maker; for a Thrashing Machine with loose Beaters.*

Dated October 30, 1804.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Thomas Noon do hereby declare that my said invention is fully described and ascertained by the drawings in the margin of these presents, and which I explain in manner following; that is to say:

Fig 1, (Plate V.) is an elevation or side-view of the machine at rest; and Fig. 2, is a plan or bird's-eye-view of the same, of two-horse power, each drawn upon a scale of half an inch to the foot. The same letters on each of the drawings refer to the same parts in each figure. *a*, is a cylinder or drum upon which the loose beaters *b* are hung by means of the pivot ends *c*. *d d*, are two fluted rollers, through which the corn is introduced into

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the machine, to be thrashed from the feeding-board in the common way. These rollers must be pressed towards each other by means of springs, weights, or any other mode, so as to hold the straw sufficiently tight in its passage through them while the beaters separate the corn from it. Underneath these rollers is a trough *f f*, ribbed or fluted within, the whole width of the cylinders, and about one-third of its circumference, against which the beaters strike, and thereby separate the corn from the straw, and deliver both out at the other end of the said trough, where it may pass over, if thought proper, a screen to be winnowed. *g*, is a screw, to raise or fall the trough *f f*, under the cylinder or drum, as circumstances may require, for different sorts of grain. Any other convenient method may be used for this purpose. *h h*, are two wheels for turning the fluted rollers *d d*; the smaller one of which is driven by the wheel *i*, which is connected to the horizontal shaft *k*, Fig. 3, by means of the click-wheel *l*, when it is intended to work the machine by horse, or other superior power. This click-wheel is so constructed that no accident can happen either to the machine or horse should the animal suddenly stop. It consists of a flat iron plate *l*, on which are fixed the two triangular clicks *m m*, the upper part of which is rounded off. Under the clicks are fixed two steel springs *n n*, to keep them up. When the horse or other power drives the horizontal shaft *k*, a cross bar *o* on its end is forced against the square or upright sides of the clicks, and thereby gives motion to the machine. But should the horse suddenly stop, or should the shaft *k*, by any other means, be suddenly checked, the machine would continue its course (from the velocity acquired by the fly-wheel) without injury until it stopped of

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Fig. 2.

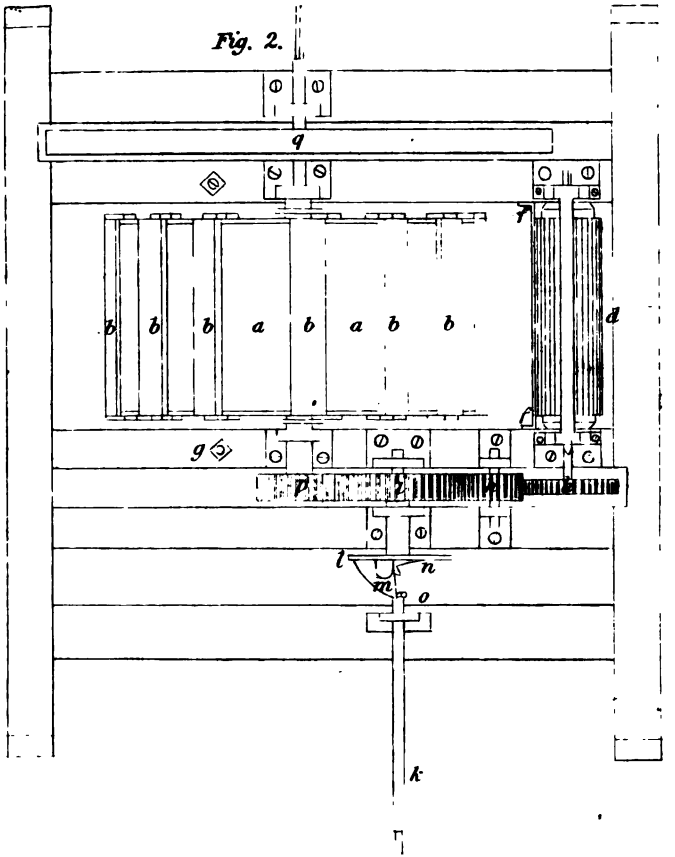
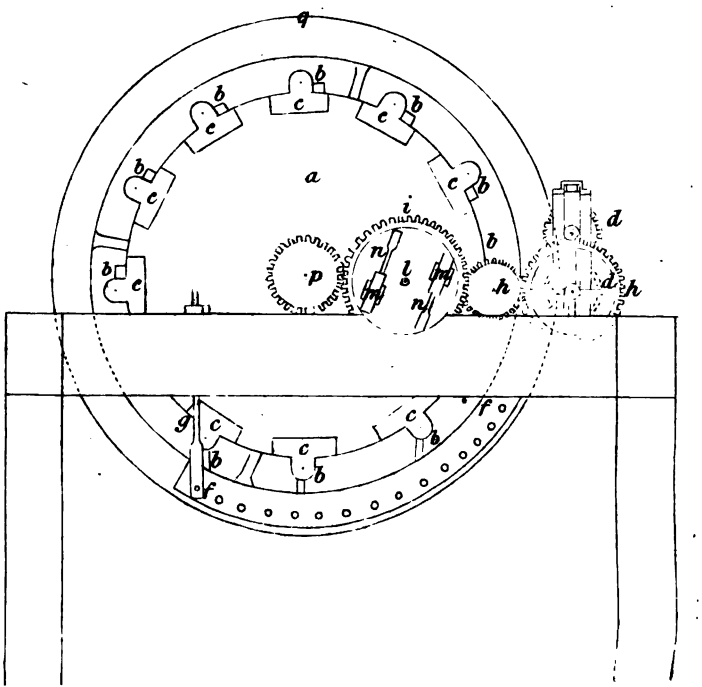


Fig. 1.



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of itself; for the clicks would then meet the bar *o* the contrary way, and slip over it. This contrivance may be applied to considerable advantage in various other kinds of machinery. *p*, is a wheel for giving motion to the cylinder or drum, on the axis of which it is fixed, and which is driven by the wheel *i*. On the other end of the axis a fly-wheel *q* is fixed, for the purpose of steadying the motion of the machine, &c.

I do not think it necessary to mention the various materials of which the machine should be constructed, as every workman must be a competent judge of that matter, and will vary them according to circumstances. The drawings represent a machine of two-horse power, which will cause the cylinder or drum to make about one hundred revolutions in a minute, which velocity may be increased or diminished by altering the number of wheels or cogs on the wheels either belonging to the machine or the horizontal shaft, or by any other well-known means.

The advantages arising from this machine are very considerable, it having less friction than any other that has hitherto come to my knowledge, and consequently it does more work with the same power, and less injury to the straw. It is also less liable to accidents, and when out of order may be repaired by a common workman.

In witness whereof, &c.

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Specification of the Patent granted to ARTHUR WOOLF, *of Wood-street, Spa-Fields, in the County of Middlesex, Engineer; for certain Improvements in the Construction of Steam-Engines.* Dated June 7, 1804.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Arthur Woolf do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed as follows; that is to say: I have ascertained by actual experiments, and have applied the same to practice, that as in practice it is found that steam acting with the expansive force of four pounds the square inch, against the safety valve exposed to the atmosphere, is capable of expanding itself to four times the volume it then occupies, and still to be equal to the pressure of the atmosphere; so in like manner steam of the force of five pounds the square inch can expand itself to five times its volume. Masses or quantities of steam of the like expansive force of six, seven, eight, nine, or ten pounds the square inch, can expand itself to six, seven, eight, nine, or ten times its volume, and still be respectively equal to the atmosphere, or capable of producing sufficient action against the piston of a steam engine, to cause the same to rise in the old engine (with a counterpoise) of Newcomen, or to be carried into the vacuous part of the cylinder in the improved engines, first brought into effect by Boulton and Watt; and this ratio is progressive, and nearly, if not entirely uniform; so that steam, the expansive force of twenty, thirty, forty, or fifty pounds, the square inch of a common safety-valve, will expand itself to twenty, thirty, forty, or fifty times its volume; and generally, as to all the intermediate or higher degrees of elastic force, the number

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ber of times which steam of any temperature and force can expand itself, being nearly the same as the number of pounds it is able to sustain on a square inch, exposed to the common atmospheric counterpressure; provided always, that the space, place, or vessel, in which it is allowed to expand itself, be at least of as high a temperature, or nearly as high a temperature, as that of the steam before it be allowed room to expand; that is, whatever be the degree of heat necessary to the permanency of steam of the force of twenty pounds the square inch, if steam of that force be employed, the space, place, or vessel in which it is allowed or intended to expand itself, should be of the same temperature or nearly so; and so with steam of any other power, as of thirty, forty, or fifty pounds the square inch; the space, place, or vessel, in which it is to expand, should be at or about the same degree of heat as steam of the force employed requires for its existence; in which case, as I have before stated, steam can expand itself about as many times as the number of pounds it could have sustained on a square inch as aforesaid, before it is allowed to expand or dilate itself. Here, however, it may be necessary to remark, that in stating this ratio, I only speak of the expansion of steam as it can be managed and commanded in practice, and not of the absolute expansion which perhaps might be obtained, if mechanism could be made so perfect as to prevent all escape of steam, and all partial condensation of it and waste of heat; for the real expansive force of steam, I am inclined to believe, from the experiments I have made, increases in a regular ratio a little beyond what I have stated, though I would not recommend that it should be calculated higher in applying it to steam engines, because the difficulty of confining and managing it increases also as the elasticity of the steam is increased, or as its temperature is increased.

And

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And here it may be of use to the public to state some facts respecting different degrees of temperature required to bring steam to, and maintain it at different expansive forces above the weight of the atmosphere; because the temperature of the steam indicated by a thermometer, having its bulb in the boiler which produces it, will indicate the expansive force of the steam, without the trouble and inconvenience of changing the weights on the valve, by which its force is regulated for the work intended to be performed by it, and which valve acts as a common safety-valve, so that those who attend the boiler will know with sufficient precision by looking at the thermometer how they ought to feed the fire; and, moreover, the relation between the temperature and the expansive force being known, the danger of accidents from the safety-valve becoming deranged will be lessened, for the workman will naturally be led to notice whether the safety-valve acts freely, when the thermometer has risen to the degree that answers to the weight with which the valve is loaded for working. I have found by actual experiment, setting out from the boiling point, or two hundred and twelve degrees of the thermometer commonly employed in this country, which is that of Fahrenheit, at which degree steam of water is only equal to the pressure of the atmosphere, that, in order to give it an increased elastic force equal to five pounds the square inch, the temperature must be raised fifteen or sixteen degrees, or to about two hundred and twenty-seven and a half, when the steam will have acquired a power to expand itself to five times its volume, and still be equal to the atmosphere, and capable of being applied as such in the working of steam engines according to my said invention. And with regard to various other pressures, temperatures, and expansive forces of steam, the same are shewn in the following table.

Table

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Table of the relative pressures *per* square inch. Temperatures and expansibility of steam at degrees of heat above the boiling point of water, beginning with the temperature of steam of an elastic force, equal to five pounds per square inch, and extending to steam able to sustain forty pounds on the square inch.

Pounds per square inch.	Degrees of heat.	Expansibility.
Steam of an elastic force 5	requires to be maintained $227\frac{1}{2}$	and at these respective 5
predominating over 6	by a temperature equal $230\frac{1}{4}$	degrees of heat, steam 6
the pressure of the 7	to about $232\frac{3}{4}$	can expand itself to 7
atmosphere upon a 8	$235\frac{1}{4}$	about 8
safety-valve, 9	$237\frac{1}{2}$	9
10	$239\frac{1}{2}$	10
15	$250\frac{1}{2}$	15
20	$259\frac{1}{2}$	20
25	267	25
30	273	30
35	278	35
40	282	40

times its volume, and continue equal in elasticity to the pressure of the atmosphere.

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And so in like manner, by small additions of temperature, an expansive power may be given to steam, to enable it to expand to fifty, sixty, seventy, eighty, ninety, one hundred, two hundred, three hundred, or more times its volume, without any limitation but what is imposed by the frangible nature of every material, of which boilers or other parts of steam engines have been or can be made; and prudence dictates that the expansive force should never be carried to the utmost the materials can bear, but rather be kept considerably within that limit.

Having thus fully explained my discovery of the expansive power and force of steam, I shall proceed to describe my improvements grounded thereon; and in so doing, I shall find it necessary to mention the entire steam engine and its parts to which as an invention well known I neither can nor do assert any exclusive claim; but at the same time I must here observe, that, from the nature of my said discovery and its application, there can be no difficulty in distinguishing my said improvements from the improved engine, as to its other common and well-known component parts.

First, if the engine be constructed originally with the intention of adopting my said improvements, it ought to have two steam vessels of different dimensions, according to the temperature or the expansive force determined to be communicated to the steam made use of in working the engine; for the smaller steam vessel, or cylinder, must be a measure for the larger. For example, if steam of forty pounds the square inch is fixed on, then the smaller steam vessel should be at least one fortieth part the contents of the larger one. Each steam vessel should be furnished with a piston, and the smaller cylinder should have a communication both at its top and bottom (top and bottom being here employed merely as relative terms,

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terms, for the cylinders may be worked in a horizontal, or any other required position as well as vertical). The small cylinder, I say, should have a communication both at its top and bottom with the boiler which supplies the steam, which communications, by means of cocks or valves of any construction adapted to the use, are to be alternately opened and shut during the working of the engine. The top of the small cylinder should have a communication with the bottom of the larger cylinder, and the bottom of the smaller one with the top of the larger, with proper means to open and shut these alternately by cocks, valves, or any other well-known contrivance. And both the top and bottom of the larger cylinder or steam vessel should, while the engine is at work, communicate alternately with a condensing vessel, into which a jet of water is admitted to hasten the condensation; or the condensing vessel may be cooled by any other means calculated to produce that effect. Things being thus arranged, when the engine is at work, steam of high temperature is admitted from the boiler, to act by its elastic force on one side of the smaller piston, while the steam which had last moved it has a communication with the larger steam vessel or cylinder where it follows the larger piston now moving towards that end of its cylinder which is open to the condensing vessel. Let both pistons end their stroke at one time, and let us now suppose them both at the top of their respective cylinders, ready to descend; then the steam of forty pounds the square inch entering above the smaller piston will carry it downwards, while the steam below it, instead of being allowed to escape into the atmosphere, or applied to any other purpose, will pass into the larger cylinder above its piston, which will take its downward stroke at the same time that the piston of the smaller cylinder is doing the same thing; and while this goes on, the steam which last

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filled the larger cylinder in the upward stroke of the engine will be passed into the condenser, to be condensed during the downward stroke. When the pistons in the smaller and larger cylinder have thus been made to descend to the bottom of their respective cylinders, then the steam from this boiler is to be shut off from the top, and admitted to the bottom of the smaller cylinder, and the communication between the bottom of the smaller and the top of the larger cylinder is also to be cut off, and the communication to be opened between the top of the smaller and the bottom of the larger cylinder, the steam, which in the downward stroke of the engine filled the larger cylinder, being now open to the condenser, and the communication between the bottom of the larger cylinder and the condenser shut off; and so alternately admitting the steam to the different sides of the smaller piston, while the steam last admitted into the smaller cylinder passes alternately to the different sides of the larger piston in the larger cylinder, the top and bottom of which are made to communicate alternately with the condenser. In an engine working with the improvements which have been just described, while the steam is admitted to one side of the piston in the smaller cylinder, the steam on the other side has room made for its admission into the larger cylinder on one side of its piston, by the condensation going on on the other side of the large piston which is open to the condenser; and that waste of steam, which takes place in engines worked only by the expansive force of steam, from steam passing the piston, is prevented, for all steam that passes the piston in the smaller cylinder is received into the larger. In such an engine, where it may be more convenient for any particular purpose, the arrangement may be altered, and the top of the smaller made to communicate with the top of the larger, and the bottom of the smaller with the bottom of the larger cylinder;

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der; in which case the only difference will be, that when the piston in the smaller cylinder descends, that in the larger will ascend, and while the latter descends the former will ascend; which for some particular purposes may be more convenient than the arrangement before described.

Secondly, as the difficulty of giving a proper degree of strength to large cylinders, and the cases for the same which are to be exposed to the action of strong steam, increases in proportion as their size is augmented, instead of employing, besides the smaller cylinder or steam measure, one cylinder only of large diameter in steam engines of great power, I sometimes prefer substituting for the latter cylinder two or more cylinders of smaller diameter, but of such dimensions that their capacity and the area of the pistons worked in them are equal to the area of the one piston, and the capacity of the one cylinder, which otherwise would be necessary; and such substituted cylinders are made to communicate with each other, that they may at one and the same time receive and part with the steam by which the engine is worked; and their respective piston rods are so connected with one another, or with other parts of the machinery, that the pistons may act together.

Thirdly, with regard to steam engines, which are already constructed, I improve the same by adding thereto a small cylinder or measure for the steam admitted to the working cylinder; this improvement may be introduced with great advantage into the steam engines, constructed according to Mr. Watt's improvements, which small cylinder may be either employed only as a measure of the steam, or a piston may be worked in it by the expansive force of the steam, before it be allowed to pass into the present working cylinder or steam vessel, which in that

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case must have no direct communication with the boiler, but must be supplied with steam through the medium of the small added cylinder or steam measure. To make this more intelligible, suppose the steam measure or small cylinder added to one of Mr. Watt's single engines, or to one of similar construction, and that the small added cylinder is furnished with a piston, to work by the expansive force of the steam, while the larger cylinder works by condensation, then all that is necessary is, that the top of the smaller added cylinder be connected with the boiler, and furnished with a cock or valve to shut off the steam, and the boiler be of sufficient strength: let a pipe pass from the top to the bottom of the smaller added cylinder, furnished with a cock or valve, by which a communication may be made between the two sides of the piston in the said cylinder; let a pipe also pass from the bottom of the smaller cylinder to the top of the larger; let the larger cylinder, as is now commonly the case in practice, have a pipe passing from its top to its bottom, by which a communication can be made between the two sides of the piston in the large cylinder; and let the large cylinder communicate with a condensing vessel, with valves, cocks, or any other contrivance to open or shut the different communications when necessary; things being thus arranged, suppose the engine at work, and the pistons in both cylinders at the top of their respective cylinders, and suppose the steam admitted to enter the small cylinder above the piston; while the steam is thus entering, let the communication between the bottom of the small cylinder and the top of the large one be open, while the bottom of the large one is open to the condenser, then both pistons will descend. When they have reached the bottom of their respective cylinders, the communications between

the

the boiler and the small cylinder, between the small cylinder and large cylinder, and between the latter and the condenser, must all be shut off; and the communications must be opened between the two sides of the smaller piston, and between the two sides of the larger piston; then as the pistons ascend, the steam which was last admitted above the small piston will pass to its under-side, while the steam which was last admitted to the top of the large from the lower part of the small cylinder will pass into the lower part of the large cylinder under its piston, and both pistons will at the same time ascend by the action of the counter-weight, or the momentum of the fly, as the case may be. When both pistons have reached the top of their respective cylinders, the last-mentioned communications are shut, and the others are opened as before, and both will descend; the steam which was last admitted to the under-side of the small piston passing into the upper end of the large cylinder, while the steam last introduced below the piston of the large cylinder goes off to the condenser; or an arrangement similar to the following may be adopted: let only the bottom part of the smaller cylinder have a communication with the boiler, and let there be also a communication between the bottom of the smaller and the top of the larger cylinder, and another communication between the top part of both cylinders, which last-mentioned communication always remains open; and let the top and bottom of the large cylinder also communicate by means of a side-pipe; and let the bottom part of the large cylinder communicate with a condenser. Things being thus arranged, when steam is admitting into the lower part of the smaller cylinder, the piston in that cylinder will ascend; the communication between the top of the two cylinders being then open, to allow the

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the steam above the smaller piston to pass into the top of the larger, where it is not to be detained, but along with the steam above the piston in the large cylinder, to be allowed to pass under the last-mentioned piston (which is now ascending as well as the piston in the smaller cylinder), the communication between the two sides of the large piston being now open, and the communication with the condenser shut off. Both pistons having reached the top of their respective cylinders, the communications which before were open must now be shut (excepting the communication between the two cylinders at their upper part), and the communications between the bottom of the small and the top of the large, and between the bottom of the large and the condenser, must be opened; the steam last admitted into the lower part of the smaller cylinder will now ascend into the top of the larger and expand itself, following the piston of the larger cylinder which is now descending, its other side being open to the condenser, and (as the tops of the two cylinders communicate) steam will also pass into the top of the smaller cylinder above its piston, so that both pistons descend together to the bottom of their respective cylinders, when a fresh charge of steam is again to be admitted for a fresh stroke of the engine.

Fourthly. If my improvements be applied to one of the engines known by the name of Watt's Double Engine, the working cylinder must have no direct communication with the boiler; but must be made to communicate at its top and bottom alternately with the lower and upper part of the smaller added cylinder, or simply, as the case may be, at its top and bottom, with the steam measure, which has a direct communication with the boiler; the effect of which must be sufficiently obvious from the details I have already given respecting the

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the nature of my invention, and the way in which the same is to be carried into actual practice.

Fifthly. With regard to steam engines, in which the separate steam measure may not be thought adviseable, the same may be improved by the appplication of my aforesaid discovery, by making the boiler, and the steam case or cases in which the working cylinder or cylinders is or are inclosed, much stronger than usual; and by altering the structure and dimensions of the cocks, valves, slides, or other means of admitting steam from the boiler into the cylinder or cylinders, in such a manner as that the steam may be admitted very gradually by a progressive enlargement of the aperture, so as at first to wiredraw, and afterwards admit more freely the same. The reason for this precaution is this: steam of such great elastic force as I employ, if admitted suddenly into the cylinder or cylinders, when more than one working cylinder is employed, would strike with a force that would endanger the safety and durability of the engine. The aperture allowed to the valve, cock, or other contrivance for admitting steam into the cylinder or cylinders, should be regulated by the following consideration. If the intention is that the engine should work only, or almost wholly, by condensation, the steam in passing into the cylinder or cylinders should be forced to wiredraw itself, as I have already said, but so that the piston or pistons may perform the whole or a great part of the stroke by the time the intended quantity of steam has been admitted into the cylinder or cylinders; for example, when steam of forty pounds the square inch is used, such a quantity of the same as shall be equal in volume to one fortieth of the capacity of the cylinder or cylinders, and so in proportion when steam of any other force is employed; and when the

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the requisite quantity has been admitted, the steam is to be shut off till the proper moment for admitting a fresh quantity. But if it is intended that advantage shall also be taken of the elastic force of the steam acting on one side of the piston or pistons, while condensation goes on the other side, then the steam must be admitted more freely, but still with caution at the first, for the reason already mentioned. And in this as well as in every other application of my said improvements, grounded on my said discovery of the law of the expansibility of steam, due and effectual means must be used to keep up the requisite temperature of all the parts of the apparatus into which the steam is admitted, and in which it is not intended to be condensed. And here it may be proper to state, that, instead of the obvious and usual means for accomplishing this, namely, inclosing them in the boiler, or in a steam case or cases communicating with the boiler, the following method may sometimes be used with advantage, *viz.* a separate fire under the steam case or cases, which, in that event, will become a boiler or boilers, and must be furnished with a safety-valve or valves to regulate the temperature. By means of the last-mentioned arrangement, the steam from the smaller cylinder or steam measure (when either of these are employed) may be admitted into the larger cylinder or cylinders kept at a higher temperature than the smaller, by which its power to expand itself may be increased; and on the contrary, by keeping the larger at a lower temperature than the smaller, its expansibility will be lessened, which, on particular occasions, and for particular purposes, may be desirable. In every case care must be taken that the boiler, the case or cases in which the cylinder or cylinders is or are inclosed, the steam pipes, and generally all the parts

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parts exposed to the action of the expansive force of the steam, be of a strength proportioned to the high pressure to which they are to be exposed. With regard to the due degrees of strength of the parts of all my said improvements, together with the nature of the materials, and the proportions of the same, except as herein described, I forbear any farther description, on account of the numerous variations to which the same must be subjected; and because every engineer, of sufficient skill to be employed in works of this nature, will, without difficulty, arrange and determine the same according to the nature of the case.

Lastly. I have to observe, that, to avoid unnecessary tautologies in speaking of the proportion that ought to subsist between the smaller cylinder or the steam-measure and the larger cylinder, or the quantity of steam to be admitted to the working cylinder, where a separate smaller cylinder or steam-measure is not adopted, though I have mentioned the regular proportions, as, for example, of a measure or quantity equal to one fortieth of the working cylinder when steam of forty pounds the square inch is to be employed, or equal to one thirtieth, or one twentieth, when steam of thirty or twenty pounds the square inch is to be used; yet these are not the only proportions that may be used, for, though it may not be adviseable that the proportion of the smaller cylinder or steam-measure should in any case be made much smaller than I have stated, yet, in making it larger, considerable latitude may be allowed; for example, with steam of forty pounds the square inch a smaller cylinder or measure of one twentieth, or even larger, or of some intermediate proportion, may be employed instead of one of a fortieth of the capacity of the larger or working cylinder; and so with steam of any other given

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strength. And it may be adviseable, that in a number of engines this should be the case, because of the difficulty of preventing some waste of steam or partial condensation which might lessen the rate of working, if not allowed for in the size of the smaller cylinder or steam-measure; or in the quantity of steam admitted directly from the boiler into the working cylinder, where no smaller cylinder or steam-measure is employed; and in every case the engine, when got ready for work, whatever may be the proportion that has been adopted as intended to be worked with, should have its power tried, by altering the load on the valve that ascertains the force of the steam, in order that the strength of steam best adapted for the engine may be ascertained; for it may turn out to be advantageous that the steam should be employed, in particular engines of an elastic force, somewhat over or under what was first intended.

In witness whereof, &c.

Specification of the Patent granted to RICHARD BATE, *of Little Hulton, near Bolton, in the County Palatine of Lancaster, Fustian Weaver; for a Machine to pump Water, and other useful Purposes.*

Dated November 26, 1791.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Richard Bate do hereby declare that my said invention of a machine to pump water, and other useful purposes, is described in the plan and description thereof hereunto annexed.

In witness whereof, &c.

DESCRIPTION

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Description of the Drawings.

Fig. 1, Plate VI. is an horizontal view of the engine or machine, part thereof being a frame of wood. A A A A A, five ribs, placed two inches asunder, for the purpose of letting the different wheels of the said machine, and the two beam-levers D D, to work and pass in the distances, (in the said figure,) and also in Fig. 2. Fig. 3 is a new-constructed lever, with a segmental circle of brass or iron at one end thereof, containing a variable number of teeth, moving or working upon an iron crank, with an iron notch, returned catch and stop, fixed upon one end of the crank and the head-stock in which the said crank is fixed; the notch and catch being to keep the teeth of the said segmental circle firm in the teeth of the lever-wheel N, in both Fig. 1 and 2, during every stroke or return of the lever, and the stop to lift up the catch at the end of every stroke or return to make or effect a new one, for the purpose of setting or putting, continuing, and keeping, the whole of the wheels and other works or movement contained and fixed in the said machine in motion. K, the iron crank. L, the returned catch. M, the notch to receive the catch, and O the stop to lift the notch M at the end of every stroke or return of the lever C. O, in Fig. 1, is an iron axle, which lieth horizontal to, and extends from, one side of the said frame to the other, in five separate steps of brass, fixed separately upon five wooden head stocks, for such axle to lie in, and move and turn round upon, (the two steps in each of the outsidemost head stocks covering each end of such axle, and keeping the same firm in the said five stops); which said axle passes through four iron wheels, fixed fast upon the squares of the said axle, which wheels are for the follow-

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ing purpose; *viz.* the above-mentioned lever-wheel (whose diameter is five inches and one-tenth of an inch in the above-described drawing, marked N, Fig. 1,) receives and is worked by the teeth in the said segmental circle at the end of the aforesaid lever, which lever-wheel turns the axle, and the three other wheels thereupon fixed as aforesaid. The beam lever-wheels E E, in the same figure, (whose respective diameters are nine inches and five-tenths of an inch in the model,) being toothed half way round their respective circumferences, work the hereinafter mentioned and described beam levers F F in same figure. (The toothed-parts of these two last-mentioned wheels are reversed; that is to say, the teeth of the one wheel are uppermost when those of the other are underneath or below the centre of such other wheel, in order to work the said beam-levers alternately, the one rising whilst the other is falling.) And the other toothed-wheel G, in said Fig. 1, (whose diameter in the same model is also five inches and one-tenth part of an inch,) works and turns two other wheels, the one marked H in said Fig. 1, (whose diameter is also five inches and one-tenth part of an inch); but the other being a multiplying wheel, on one inch and nine-tenths of an inch in diameter in the aforesaid model, lying exactly underneath the wheel G, cannot be seen in said Fig. 1, which wheel H turns another multiplying wheel of the same diameter of the last-mentioned multiplying wheel, fixed upon the axle of the fly-wheel B *b*; which fly-wheel regulates the motion of all the said wheels N E E G H, and the multiplying wheel underneath the wheel H. D and D, in both Figs. 1 and 2, are beam-levers, of twenty-six inches and one-tenth of an inch each in length from the extreme ends to the sweep of the segmental circle thereon hereinafter described, and twenty inches from the respective

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tive centre or axis of such beam-levers to such sweeps of the said segmental circle, and which sweeps are respectively fifteen inches and eight-tenths of an inch in length, fixed upon the axle P; the segmental head parts being of wood, with a segmental circle of brass screwed to each, containing thirty-four teeth in the said model, more or less, and which same teeth meet and respectively enter the teeth of the said beam-lever wheels E E above described. From each of which beam-heads hang suspended the weights marked X X, in order to increase their power in dropping after their respective teeth have parted from, or quitted those in the respective beam-lever wheels, whereby the power of the wheels upon the axles P and U are greatly increased. Upon which axle P are fixed two detent or saw-toothed wheels Q Q, which pass through a notch, nick, or opening, in the said extreme ends of each beam-lever, which being held, stopped, or detained, by two iron stays, causes the action of the axle U, in both the said Figs. 1 and 2, placed underneath the axle P and the two wheels thereupon fixed marked S, in Fig. 1, whose diameter is also five inches and one-tenth part of an inch in the aforesaid model; but the other being a multiplying wheel also, of one inch and nine-tenths of an inch in diameter in the aforesaid model, lying exactly underneath the wheel S, cannot be seen. Which two last-mentioned wheels turn the other fly-wheel B; which fly-wheel regulates the motion of all the said wheels, fixed upon the said two axles P and U; which axle U being made square at one end, and extending two inches in the said model, from or out of the said frame, enters into a square socket in the centre of the wheel A, Fig. 4, whose diameter is two inches and seven-tenths of an inch in the said model, and

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and thereby works the bucket-pump, Fig. 4, hereinafter described.

Fig. 4, is a new-invented bucket-pump, for the purpose of raising large quantities of water, which may be afterwards turned upon a water-wheel. The wheel A, whose diameter in the said model is two inches and seven-tenths of an inch, being fast upon the same axle with the roller D *d*, the square socket fixed upon or in the centre thereof receives the square end of the axle U, in Figs. 1 and 2, D *d*. D and D are octagonal rollers, whose respective diameters are three inches and eight-tenths of an inch in the same model, turning upon their respective axis for the purpose of turning the cans or buckets of the same pump. (See Fig. 5.) E E and E, being three of the respective cans or buckets fixed to certain links of iron, as being described, Fig. 6, being a link, and Fig. 7, being a link and can, fixed together, which go round the aforesaid rollers D *d*, D and D, and are filled with water along with the rest of the cans or buckets, as described in Fig. 4, and are filled with water out of a trough or reservoir of water, to be placed at the foot or bottom of the same pump; and when they respectively arrive at F, empty themselves into the trough G; which water runs out of the same trough at H, in said Fig. 4, upon or into the buckets of a water-wheel.

N. B. The above machines and parts thereof may be made of different sizes and dimensions at pleasure.

Specification

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Fig. 1.

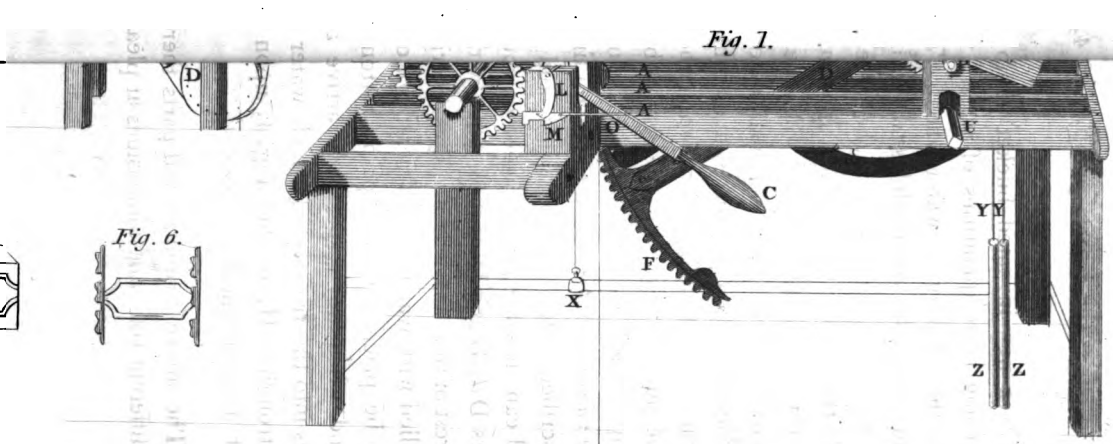

Fig. 7.

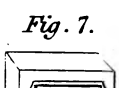

Fig. 6.

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Specification of the Patent granted to ROBERT FRITH, *of Broughton, in the County of Lancaster, Dyer; for an improved Method of dyeing Cotton Wool, Cotton Twist, Cotton Weft, and Cotton Cloth, of a Nankeen Colour and of a Buff Colour.* Dated October 3, 1804.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in pursuance of, and in compliance with, the said recited proviso, I the said Robert Frith do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, is as follows: My invention or discovery of an improved method of dyeing cotton wool, cotton twist, cotton weft, and cotton cloth, of a nankeen colour, and of a buff colour, consists in the use, either conjoined or successive, of an infusion or decoction of galls, mahogany bark, alder bark, oak bark, elm bark, schumach, and madder, or of any one, two, or more of them, and of a solution of iron, prepared by means of the sulphuric, nitric, muriatic, and acetous acids, or any one or more of them, or by any other acid or acids commonly used for such solutions, or prepared in any other way in which the solution of iron, commonly called iron liquor, is prepared.

And I disclaim under this patent the use either of the above infusion or decoction solely, or of the above solution solely; and confine my invention or discovery, and right to the use of both, either jointly or successively, the same having never been before, either jointly or successively, used in the same process in dying buff or nankeen, and being substances which probably were not tried for that purpose, because they are the common ingredients used in making black ink.

I also disclaim any right to the invention of making or preparing the above infusion or decoction, and solution,

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tion, or any of them, reserving nevertheless to myself such right as I have under a former patent *, dated May 25, 1798, to my invention of a then new chemical method of dying different permanent colours upon cotton, linen, woollen, and silk, for the term in such former patent mentioned.

As it is necessary in the use of my invention here specified to connect it with other processes in dyeing before known, I shall now state the manner in which I most commonly connect it with other processes, and which I believe to be the most advantageous mode of connecting or using it. After washing the substance to be dyed in hot water: first, I dip it into an infusion or decoction of galls, mahogany bark, alder bark, oak bark, elm-bark, schumach, and madder, or of any one, two, or more of them. Secondly, I pass it through a solution of iron, prepared as before mentioned. Thirdly, I wash it well in warm water. Fourthly, I pass it through a solution of soap in water, or through a solution of any of the alkalies, either mild or caustic, in water, or through lime-water. Fifthly, I dip it, while remaining wet, into a solution of tin prepared by means of either the nitric acid, or the muriatic acid, or the nitro-muriatic acid, diluted with water. After washing the substance so dyed in warm water, and drying it in the usual way, the operation is complete. The first and second operations may be performed in a different order; that is, the substance to be dyed may be first put into the solution of iron, and afterwards dipped into the before-mentioned infusion or decoction, or the infusion or decoction and solution of iron may be mixed together, and the substance to be dyed may be passed through the mixture; but I prefer

* Published in the thirteenth volume of the first series of this work, page 380.

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the successive use of the infusion or decoction, and the solution of iron, in the order in which I have first mentioned them.

It may be proper to state, for the information of those persons who are not conversant with the art of dying, that in the above process an infusion or decoction of galls produces a yellowish-buff colour, and that the addition of a small quantity of mahogany bark or alder bark to the infusion or decoction of galls produces a proper buff colour; and that the addition of a greater quantity of mahogany bark or alder bark to the infusion or decoction of galls produces a nankeen colour, the proportions of each of which may be varied according to the shade of colour which the dyer wishes to produce.

In witness whereof, &c.

Method of preventing Accidents to Horses and Carriages in going down Hills, by a Gripe or Clasp acting on the Naves of the Wheels of the Carriage.

By Mr. WILLIAM BOWLER, *of Finsbury-street.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

Ten Guineas were presented to Mr. BOWLER *for this Invention.*

BY means of this contrivance a cart may be stopped in an instant in going down the steepest hill with a load, without stopping the horses, by the carter only pressing his hand upon a lever. This plan would likewise be highly advantageous in case of a horse taking fright, as the carriage may be instantly stopped by the brace clasping

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ing the wheels. It may also, with little alteration, answer for a broad-wheel waggon with a heavy load. By the present method a coachman, whilst sitting on his box, may confine or release the wheels of his carriage at pleasure, and prevent accidents in descending hills, or in managing restive horses.

REFERENCE to the ENGRAVING, Fig. 1, Plate VII.

A B, the extent of the body of the cart.

C D, the two shafts.

E, the front ladder of the cart, part of which projects over the shafts, and is supported on them: the other part is fastened to the upright piece F.

G, the handle of the lever, sliding betwixt two uprights, and moveable on an iron bar and pivot at H, in the upright piece F. By pressing down this handle, the moveable joints I K raise upwards the lower part of another lever L, so as to press against the lower part of the nave of the wheel, and at the same time the moveable joints press down the lever O, and cause this lever to act against the upper part of the nave of the wheel; thus compressing the nave of the wheel betwixt a double brace, and either retarding wholly the motion of the wheel, or allowing it to move a little, as may be thought requisite. The circle of the nearer wheel is shewn by the dotted lines P; but this wheel is not added, as it would prevent this gripe from being clearly seen. The handle of the lever G produces at the same time a similar effect on the further wheel R, by means of the bar of iron which crosses the cart at H, and acts in the same manner on similar double joints at the other side of the cart, as may be seen at S, where the farther double gripe is shewn pressing on the nave of the farther wheel.

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T, a small catch, which, by falling into the notches or teeth of the lever, when it is pressed down, holds both the gripes in one certain position.

When the wheels are to be set at liberty, the catch T is removed out of the teeth of the lever; then the lever G is raised above the hole V, and kept from sliding down by an iron pin, attached to the chain U, being put underneath the lever, through the hole V.

The iron-work is not any inconvenience in the loading or unloading of the cart, nor occupies any room within it; and, what is of material consequence in new inventions, it may be managed by the carter with much less time and trouble than the common hook and drag chain. It is also much more secure in its action, as it binds on both wheels at once, and gives a uniform steady draught for the horses, which prevents them from falling down.

Method of raising a Roof sunk in the Middle.

Invented by Mr. JAMES WOART, *of Fulham.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal and Twenty Guineas were voted by the Society to Mr. WOART *for this Invention.*

Fig. 2, Plate VII. shews the new and old truss combined.

A A, is the principal new truss. It is bolted into the old girder B B at C C, and also secured behind the said bolts, by firm corkings D D, four inches square, which may be made of hard wood or iron, and are let one half

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into the new principal A, and the other half into the old girder B, in order to prevent a lateral pressure upon the walls. The bolts go through the new truss A and the old girder B.

E E E E, is a square oak frame; F F, the slider within it; which slider is rather thicker than the square frame, and notched into the old king post at G, through which part it is bolted with two iron bolts.

H H H H, are four braces, framed at one end into the principal, and at the other into the square frame E. There are butments at the ends of each, and they are secured by iron plates: they are farther strengthened by two cross pieces.

I I, two bolts, with screws, extending from the top of the square frame E through the slider F; which screws serve to raise up the king post and the centre work of the old truss and roof, by means of nuts, under the sliding piece F.

K K K, are three screws, hooked at the bottom, under the old girder B, which screws should be worked at the same time the slider is screwed up, in order to raise the sunk centre of the old girder to its proper height.

L L, the wall plates on which the girder lies.

Fig. 2, the new truss shewn separate.

A A, the principals.

D D, the corkings, shown by dotted lines, being on the other side of the principals; they should be made of iron, or very hard wood.

E, the square frame, made of oak.

F, the oaken sliding piece, which is moveable in a groove, in the sides of the frame.

H H H H, the four braces, shewing their butments.

I, the nuts and screws of the two bolts in the sliding piece.

K K K,

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Fig. 2.

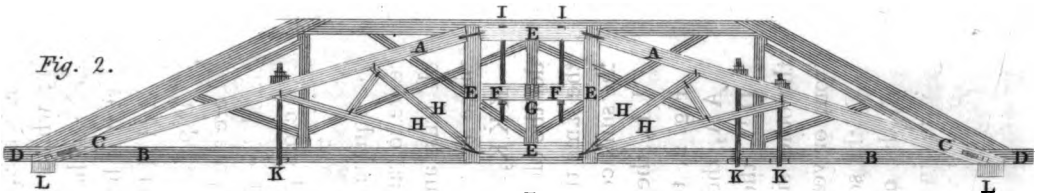


Fig. 3.

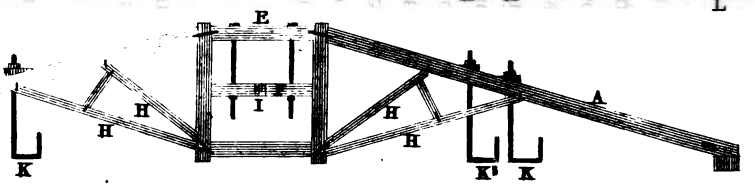
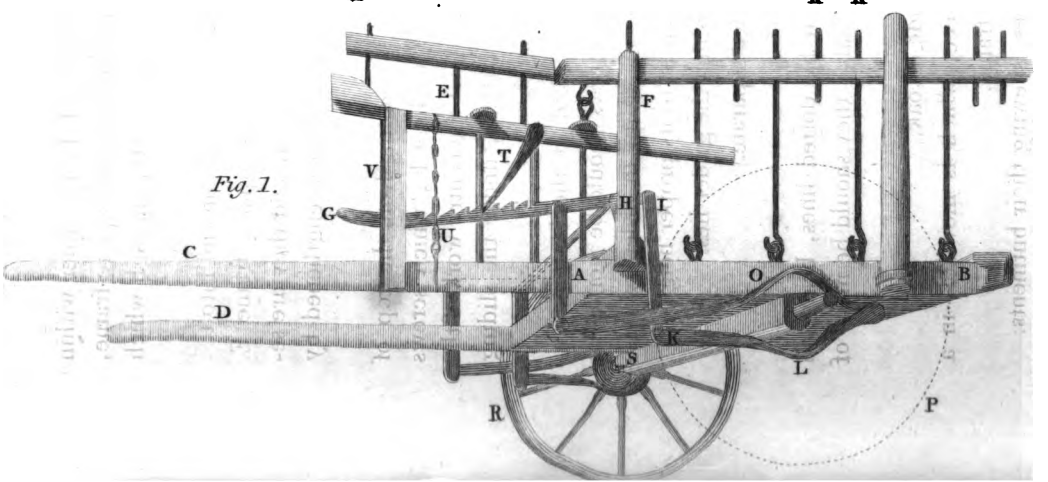


Fig. 1.



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K K K, the other screws; the hooked parts of which are exhibited in a side view, to explain their construction, and how they act upon the girder.

Letters from the Rev. John Owen, of Fulham, Mr. George Smith, of Putney, and Hennege Legge, Esq. of Putney-house, noticed in high terms Mr. Woart's character and abilities. Mr. Smith stated, in his letter of the 12th of May, the particular circumstances which occurred during the present business. H. Legge, Esq. at whose house the improvement * made by Mr. Woart, as noticed in a former volume, was executed, certified, on the 11th of May, 1803, that Mr. Woart was entitled from him to a testimony of his superior skill, and that he was also the efficient person employed on the present occasion.

Of the Saltzburg Method of bleaching Cotton; and the Art of dyeing Cotton and Flax a solid Red.

By M. C. SCHOERBRING.

From KONG. VETENSK. ACADEM. NYA HANDLINGAR.

I. THE cotton-thread is always washed before it is given to be woven. The method of washing in question renders it whiter than the ordinary bleaching. It may be performed equally well upon the woven cotton. This method of washing the cotton, which is called, for what reason I know not, the Saltzburg method, notwithstanding that it is practised principally at Ratisbon, where four families have for a long time possessed it as a secret, which has not yet transpired; this method, I say, renders

* A method of securing beams or girders of timbers decayed by time, or injured by the dry-rot. See vol. II. of the present series of this work, page 346.

the

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the cotton more pliable; the cloth which is made of it is of a closer and more even texture; the cotton does not require any farther bleaching, and when it is afterwards dyed, it takes a more beautiful, more solid, and more uniform colour. This washing is performed with soap-water and a strong ley, in the following manner.

The articles to be washed, which generally consist of cotton thread, stockings, caps, and handkerchiefs, are spread out in a large vat, and disposed in the following order. The bottom of the vat is covered with a piece of coarse linen, above which are placed, first the handkerchiefs, then the stockings and caps, and lastly the thread. The whole is then covered with another piece of coarse linen, of a close texture and very clean, in such a manner as entirely to prevent the contact of the air. A caldron, $1\frac{1}{2}$ Swedish ell in diameter above, and $1\frac{1}{4}$ below, and an ell deep, is filled with water, and a sufficient quantity of caustic ley is added to make it feel unctuous to the touch. To this water are then added 2lbs. of Ratisbon soap, in shavings. A fire is then made under the caldron, and when the ley boils it is poured upon the cotton; it is drawn off a little after, in order to heat it anew, and during this interval hot soap-water is continually poured upon the cotton. These operations are continued from four to six hours, or till it is certain that the cotton is well soaked and heated. It is then still steeped for twenty-four hours in soap-water. This operation is generally performed between midnight and six o'clock; the following morning the soap-water is drawn off, the cotton is well washed, and the water pressed out of it by means of a screw-press. This is the first washing.

When the cotton has been thus well steeped, they proceed to the principal washing in the following manner. The

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The steeped cotton is disposed in the vat as before, only with this difference, that it is surrounded with cotton instead of linen cloth, which resists less the action of the caustic ley. They must have prepared a clear and colourless ley with two-third parts of beech-ashes, and one-third part of lime. This ley is brought to that degree of concentration that an egg sinks slowly in it. The ley is boiled and poured upon the cotton; it is then drawn off, heated anew, and poured again upon the cotton. They continue to repeat this process from midnight till noon, or the space of twelve hours. The whole of the ley is then drawn off, the vat is removed, the cotton, while hot, is spread out, by means of the hands covered with gloves, upon a table, after which it is put again into the vat but in a reversed order. The same washing is repeated with cold ley, and continued for twenty-four hours.

The caldron is then filled with water, two pounds of soap put into it, and made to boil. The cotton is washed with this water, which is continually kept boiling for twenty hours, and it is left to steep for ten or eleven hours. After this, the water is drawn off, the cotton is taken out of the vat, and spread out upon a long wooden table, where they wash it with pure water, striking it with a beetle, after which it is washed in running water. Finally, the water is squeezed out by means of a press, and the cotton put to dry upon poles in the sun, or, during moist weather, in a proper chamber.

The leys of these washings cannot be employed a second time, as they have acquired the colour of blood. They are mixed together and employed for the common leying of linen. The soap-water is rejected.

The poles upon which the cotton is hung ought to be washed every time. It is preferable, when the weather permits,

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permits, to expose each piece to the free access of the air, by suspending them upon lines. The articles must not be crowded too close together, lest the parts to which the air has not free access should become stained with brown stripes.

Raw linen-cloth and thread may receive, by the same method, a half bleaching, only the ley must be made of but half the strength, and the leying must not be continued for so great a length of time as with the cotton, for fear of weakening the texture of the thread.

II. Linen and cotton, as vegetable substances, have the defect of not taking colours with solidity. The cause resides in their resinous principle, which we must endeavour to remove from them. Alcohol would be a sure and easy solvent for this principle; but its price is too high to admit of its being used for that purpose. After alcohol, the best solvents of this principle are oils of all kinds, but especially fish-oil. The cotton is steeped for twenty-four hours in this oil, after boiling it anew for the space of two hours; it is wrung out; it is suspended for some days in the air, in order that the oil may detach itself well from it; it is entirely freed from oil by the aid of a strong hot ley, and it is washed and dried. We may likewise employ for this purpose a ley of two-thirds of ashes and one-third of lime, and as much sheep's dung as both the ashes and lime taken together. The cotton is not only boiled in this ley, but it is leyed several times, and washed every time with pure water. We may likewise wash the cotton thread in water into which a quantity of potash has been put sufficient to render it unctuous to the feel. The thread is let boil in it for twelve hours, or till the ley becomes black. Then the thread is washed, and steeped in water acidulated with sulphuric acid (at most two drachms of acid to a pot of water). After steeping a full

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a full hour, it is taken out, washed, and put to dry. If the Saltzburg method of bleaching were once generally known, we should no more be obliged to buy cotton thus bleached, or to send cotton to Ratisbon to be bleached. In order to ascertain whether cotton bleached in any manner is perfectly freed from resin and fit to receive the colour, a glass is filled with water, and upon the edge of it a thread of cotton is placed, with one of its ends plunged into the water, whilst the other remains on the outside of the glass; if the end which is plunged into the water does not float at the top of it, and if the other sucks up the liquid and immediately lets some of it run down, it is a proof that the cotton has the requisite purity.

The cotton being thus purified, it must pass through three mordants; *viz.* 1. a decoction of galls, 2. a solution of tin, and 3. alum-water.

1. *Decoction of galls.* For one pound of cotton or linen thread. For the first take half a pound of black galls, and for the second a pound. Pound the galls coarsely, and boil them, together with a handful of birch-leaves, in a caldron of water with $2\frac{1}{2}$ pots of rain-water, till it is reduced to one half. Let the decoction subside, and pour the liquid, whilst still hot, through a cloth, upon the cotton; let the cotton steep in it for twenty-four hours, turning it frequently, in order that it may be uniformly penetrated with the galling principle. Then take it out, wring it, and put it to dry, suspended in a free air, or in a warm chamber. Care must only be taken that no water may fall upon the cotton, which would occasion spots in the dyeing In this operation, the thread ought to be strongly pressed together in order that the galls may penetrate it in an uniform manner. After this it is transported into a solution of tin, made

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as shall be specified, and the decoction of galls is put by, to be used in the aluming.

2. *The solution of tin* is made in the following manner. Sal ammoniac or sea-salt in fine powder are dissolved to saturation in one pound of aqua fortis. We then add two ounces of fine English tin, in shavings, or as much as the acid liquor can hold in solution. We also dissolve two ounces of sea-salt in a pint of rain-water, and pour, drop by drop, under continual stirring, the solution of tin into this saline water. We then put the galled thread into a dish of earthen ware, press it well, and pour the mixture upon it. Sometimes the thread is turned with the hand, in order to favour the penetration. The thread is covered to guard it against the access of the air, and it is left to soak for twenty-four hours. It is then taken out, wrung and put to dry in the air, or in a warm chamber, where it is left for forty-eight hours. After this it is washed with pure water, dried again, and transported into alum-water made as we are about to direct.

The remaining solution of tin is kept for a next operation. It is then sufficient to take, for one pound of thread, three-fourths of a pound of aqua fortis, and the other ingredients in proportion.

3. *Alum-water.* The alum, of whatever kind it may be, must be previously calcined for this use. A pound of crude alum is taken for a pound of thread. After it is calcined, it is pulverized and dissolved in a pint of water; to it is added a little more that a pint of the residuous decoction of galls; they are mixed well, the mixture is heated and poured upon the thread that has passed through the solution of tin. The thread is left for fourteen hours in this bath, after which it is expressed and put to dry.

Dyeing.

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Dyeing. Into a caldron of proper dimensions is put one pound of good madder, pounded or ground, which has been steeped for some hours in water; the caldron is filled with water, and placed over a moderate fire. As soon as the matter begins to be heated, the thread is put into it and continually turned. It is necessary that the thread should have been previously steeped in water, and afterwards wrung, in order that the colour may penetrate in a perfectly equal manner. The thread is left in the bath till the liquor boils. It is then taken out, well washed, the threads are arranged upon the hand, and the water is pressed out. This first dyeing gives the thread a pale red colour. The caldron is then emptied; it is filled with water, madder previously steeped in water is put into it, and heat is applied. As soon as the bath is hot, the thread is put into it, and let boil in it for a quarter of an hour. Care must be taken not to apply too strong a fire. The first bath must but just boil, for fear the thread might acquire a brown colour; but this inconvenience is not to be dreaded with the second bath, when the thread is already penetrated with the red colour. After the thread has been well washed for the second time, it must have a deep brown colour; if it has not this colour, it must be boiled anew, with a quarter of a pound of madder. After the last dyeing, the thread is washed with the hand in hot soap-water after having been washed in cold water, and it is put to dry.

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Inquiries respecting the tinning of Copper, Pewter, and Pottery. By M. PROUST.

(Continued from Page 48.)

PART II.

On the old Tinning.

DOCTOR Malouin, when he proposed the tinning with zinc, censured that which was in use, only in order to warn us, after the example of many others, against the dangers to which we were exposed by it. But how far do these dangers go? what can result from the use of a tinning more or less charged with lead? This is what no person, since that academician, has examined, or even undertaken to examine.

Kemerlin, the author of the alloys examined by Hellot and Geoffroy, Doucet, Chartier, La Folie, Buschaendorf, and a great number of others, who have been alternately the echoes of the terrors and alarms with which Europe has so long been annoyed, have likewise made no experiments to discover in how far it concerned us to mistrust these tinnings.

But chemistry, which incessantly calls our attention to the great difference which exists between metals and their oxydes, considered relatively to their salubrity, teaches us constantly that these terrors might, from different motives, be exaggerated; and that the sentence of proscription, so justly pronounced against the pernicious oxydes, ought not to be extended with such rigour to the metals which serve for their base, as that we should conceive ourselves in continual danger of our lives, because they may sometimes be used in our kitchens. Chemistry therefore, equally remote from suffering herself to be intimidated

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timidated by the common panic, and from the disposition to wish to calm our apprehensions by inspiring a security which might be attended with fatal consequences, has shewn at all times that it would be safer to abandon the uncertain principles which have served as the rule under these circumstances, and more useful to investigate with respect to each metal, what we have really to apprehend from each of them, considered as metals and afterwards as oxydes, rather than to attend to vague opinions, dictated more frequently by interested views than by a real concern for the public good.

In this state of the case, wishing to subject the question concerning the tinnings to the light of chemical analysis, which at the present day is so much more rigorous in its means than in the times of Malouin, of Geoffroy, of Macquer, &c. I imagined that the most certain means of elucidating it, as its importance requires, would be to undertake different very simple experiments, which age after age has neglected to execute notwithstanding that reason loudly demanded them. In order to place myself in the true point of view indicated by prudence, that is to say, at a certain distance from every passion, it was necessary that I should address myself to impartial readers, and for this purpose abandon many scientific terms, in order to enable them to judge for themselves of the consequences which result from these experiments. I shall begin with a general review of the metals and their oxydes; I shall confine myself, however, to those which are the most employed in the arts, and which nevertheless may be sufficient to establish the principles which we ought to have in view in order to decide impartially upon the question of tinning.

1. *Of*

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1. *Of Iron.*

Iron is a metal which is oxydated with such facility in a moist atmosphere or medium *, that there is no perceptible difference, with respect to its medicinal effect, between the internal use of iron and oxydated iron.

2. *Of Antimony.*

The oxyde of antimony at the inferior degree †, if taken in a dose exceeding some grains, might excite vomiting, convulsions of the stomach, inflammation of the intestines, and even death. For the passage of this metal through the intestinal canal commonly produces only that irritation which medicine desires, in order to obtain salutary evacuations; that is to say, an effect proportionate to the small quantity of oxyde which appears to be formed round the metal during the time that it remains in the body.

3. *Of Mercury.*

Mercury, in large doses, as it has frequently been prescribed in the disease called the Iliac Passion, has produced no other effects than salivation; whereas its oxydes at the *maximum* and at the *minimum*, taken in very small doses, would occasion very troublesome affections, of which death might sometimes be the consequence.

* Metals are oxydated more or less easily in the air, because oxygene is one of its component principles, as it is of water, acids, and an infinite number of natural bodies.

† It is known that most metals may unite with oxygene in two different, but always invariable, proportions. Oxyde at the inferior degree, is the term applied to that which contains the oxygene in the smallest proportion: twenty-two parts of oxygene combined with 100 of metal form the oxyde of antimony at the inferior degree, and thirty of oxygene the oxyde at the superior degree.

4. *Of*

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4. *Of Arsenic.*

Arsenic, considered as metal, is very nearly as hurtful as its oxyde, on account of the facility with which moisture causes it to pass into the latter state; but it has been found that, when it is preserved from that change by means of its union with sulphur, tin, lead, &c. its effects are no more so formidable. Bayen caused different animals to take arsenic combined with tin, in quantities sufficient to have deprived them of life if they had swallowed it pure, and yet none of these animals appeared to be incommoded by it. The interesting work of Dr. Renaud upon poisoning with arsenic shews of what great importance it is that metals be not judged of in the same manner as their oxydes.

5. *Of Silver.*

Silver is a metal which may be introduced into the human body without doing it any injury; but the purest oxyde of this metal impresses such a remarkable caustic taste upon the tongue, that there can be no doubt it may prove a very active poison.

6. *Of Tin.*

Tin is administered in very large doses, and without the slightest danger, against the *tænia* *, and in maladies of the liver and uterus; but the effects of its oxyde, taken internally, are not known. I do not pretend to decide in a matter on which we as yet have no experiments; but I am inclined to believe that this oxyde would not produce dangerous effects, 1, because the miners and braziers,

* The French Encyclopedia gives, from the Edinburgh Transactions, the formula of a remedy against the *tænia*, or tape-worm, in which pulverized tin is an ingredient.

who

who so frequently respire air impregnated with this oxyde occasioned by the fusion, do not experience the colics with which persons who work in lead are affected; 2, because it is demonstrated that the very small quantity of tin, which the alimentary acids extract from tinned pots, has never, as we shall see hereafter, attracted the attention of physicians by the slightest inconvenience resulting from it. *Modò purum illud nec adulteratum sit*, as Schulz says in his dissertation, intituled, *Mors in olla*. But we shall soon see that the apprehensions of this learned physician, which at present are better appreciated, were destitute of foundation.

7. *Of Copper.*

Every one knows that copper, taken in substance, may produce fatal consequences, on account of the oxydation to which it is liable in the stomach and intestines. However, the accidents are rarely so serious as might be apprehended, for we daily see children swallow copper coins and discharge them, without this imprudence ever costing any their lives. But how much greater would not the danger be if they swallowed the oxyde of this metal, even were it below the tenth part of the weight of the smallest coin?

Copper is dissolved with much greater difficulty than is commonly imagined by the vegetable acids, even when aided by ebullition. It is impossible to dissolve filings of it in vinegar, although nothing is more prompt than its oxydation, when the air and the vapour of this acid in fermentation concur simultaneously to produce this effect. But how should the vegetable acids have this power? aqueous sulphuric acid is deprived of it. Accordingly, it is a truth universally acknowledged, that the boiling of sugar, of syrups, and of acid confectionary,

of

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of the juices of plants, of the must of beer or of grapes, has never occasioned bad accidents that have been well ascertained; for it is a precaution constantly observed in the houses where these preparations and several others are made, not to let them cool or remain for a long time, after being boiled, in the copper vessels, and this with the greater reason, as the precaution is of the greatest consequence to the dealers in such provisions. If they be suffered to remain for a certain time in the vessels, they contract an extremely disagreeable taste, and a colour which would soon bring them into discredit with the consumer.

I anticipate the objection which may be made to me. Can the magistrates, it will be said, rely as to what concerns the danger of copper upon the attention and honesty of a workman whose stupid indolence is not always roused at the view of his own danger? Undoubtedly not. But we ought no more to confound the apathy of these organized machines, whose only merit consists in the strength of their arms, with the vigilant and patriotic solicitude of a father of a family, who well knows that his reputation, and the prosperity of his commerce, are inseparably connected with the purity and good quality of the provisions which are prepared under his superintendance. And a proof that we are as much indebted to the religious solicitude of the man of integrity as to the vigilance of the legislator, for the security which we enjoy in this respect, is, that we very rarely see poison issue from the houses destined for the preparation of medicines, confectionary, and aliments. Let us incessantly call to mind the dangers to which carelessness and indolence in these arts may expose the lives of our fellow-citizens. Let the legislator and the physician denounce with the voice of eloquence and persuasion against the

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dangers with which we are surrounded; but let us at the same time guard against subjecting the workshops to coercive measures, which, if they are impracticable, become illusory expedients.

In fact, in pharmacy, in confectioners' and other shops, the great copper vessels are exposed, from very powerful reasons, to lose their tinning soon, without its being possible to prevent it, although in kitchens this accident may be obviated.

All those operations of cooking, which cannot be terminated without a degree of heat superior to that of boiling water, fuse the greatest part of the tinning, and reduce it into grains like shot, as the tin, which is not combined with the copper, falls to the bottom of the boilers, a moderate degree of heat being sufficient to liquefy it.

The continual friction which inevitably takes place during the preparation of pastes, extracts, and confectionary, which are strongly agitated with wooden spatules, tends also very speedily to destroy the tinning. We cannot therefore oblige the manufacturers or workmen employed in this labour to cover the copper with a preservative which would be of no duration, and which would be very expensive if it should be renewed as often as it was destroyed. In all the arts there are certain practices which the laws can never prescribe; but the philosophic legislator brings it about that they receive their sanction from the probity of the man himself who carries them into execution.

Even those who, for some time past, professed a doctrine entirely opposite to these truths, have confirmed them when they thought least of it; so difficult is it for a person to avoid falling into contradictions when he speaks contrary to his own conviction. On one of the

arts

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arts in which vigilance against the dangers of copper is of the most essential consequence, a law has been imposed, to be always provided with three copper utensils, tinned according to the new method, namely, an alembic, a basin, and a capsule. But where is the laboratory, however small, in a capital, where we do not find twenty utensils of this kind, of all capacities? There is not a day that the workmen are not obliged to make fifty pounds or more of syrup, and sometimes of three or four different qualities. Could they make them in one of the three pieces tinned according to the regulation? These pieces will be kept by them in order to satisfy the vigilance of the magistracy, if it be required, rather than to fulfil the intention of the law, and they will always endeavour to have them of the smallest size. There are alembics of a capacity of 8, 10, and 20 *arrobes*, for making arquebusade, orange-flower water, peppermint water, &c. Will they perform these distillations in the small alembics tinned according to the new method? What is a single tinned basin for the use of a whole shop? Thus all these regulations will prove to be illusory, and fall very short of the purposes intended to be answered by them.

8. *Of Lead.*

All that has just been said of copper applies equally to lead. If the oxyde of this metal comes to mix with the aliments, or with the ambient air which the plumbers and colour-grinders are obliged to respire, it occasions those terrible colics and other disorders which Dr. Luzuriaga has so learnedly described. But lead in the mass, bullets and shot, which we introduce so frequently into our stomachs in eating game, do not expose us to very imminent dangers. This metal is not at all to be feared except in the alimentary canal; for we daily see soldiers

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who have bullets inclosed in their muscles, and who thus pass their lives without experiencing any inconvenience from them; which is owing to the circumstance that lead is oxydated but very slowly, even in humid mediums or bodies.

9. *Of Zinc.*

Respecting zinc, taken in substance, we have only ill-ascertained facts, which consequently obliges us, on this subject, to embrace the doubtful side. Patrin asserts, as has already been observed, that zinc is prescribed in Germany as an emetic and purgative. On the other hand, La Folie tells us that he has made different animals take it, without its having caused them any accident. I am much disposed to judge of zinc as La Folie does.

This philosopher, his friends at Rouen, the Abbé Rozier, author of the "Journal de Physique," Dr. Lapланche, at the request of the faculty of medicine at Paris, and several other persons, have tasted aliments prepared in pots tinned with zinc, without having experienced any inconvenience from them. With respect to the oxydated zinc, though the flowers and the sulphate of zinc are regarded as emetics, there is reason to believe that it ought to be considered in the same light as those of iron, tin, &c. on account of the force with which it retains the oxygene. Sage relates that the flowers of zinc, which raised themselves in the form of thick clouds from the fusion of bronze, did not occasion any inconvenience to the workmen in the foundery of Donay. But if, on the one hand, this oxyde is innocent in the internal use which is made of it, we shall not venture to say as much of its combination with vinegar, or of the acetate of zinc. I do not know whether we might with safety take doses of any considerable magnitude of this metallic salt, mixed with our aliments.

The

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The review which I have just given appears to me sufficient to afford the notions which we require, in order to enable us now to judge of what we wish to know respecting the ordinary tinning. And what have we to fear with respect to the lead which is an ingredient to the tinning? Is it the lead itself as metal? is it its oxyde, or else its dissolutions? It is from experiment that we must expect the solution of these problems.

PART III.

Experiments upon Tinning.

I caused five plates of copper, each a square foot, to be tinned, in order to know with accuracy the whole detail of this operation, which consists, as is known, in scraping the metal, in order to remove from it the particles of oxyde, which would impede the adhesion of the tin to the copper.

I shall class them here in the order of the losses which they underwent in the scraping.

The first lost - - - - - - - -	288 grains.
The second lost - - - - - - -	350
The third lost - - - - - - -	355
The fourth lost - - - - - - -	360
The fifth lost - - - - - - -	393

We see from these results that the quantity of metal lost in the scraping is very variable; and that it is in the power of an evil-disposed workman to cause the pieces which are intrusted to him to undergo a great loss, without the owner's being able to perceive it, or even to complain of it; for the workman claims the right of being his own judge with respect to an operation which he asserts to be necessary for the application of the tinning.

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This loss may not exceed two grains, as we see by the number 288, the double of 144, which represents the square foot; but commonly it is two grains and a half; for, at an average, the number 144 is contained two and a half times in that which expresses the loss.

It was now necessary to ascertain the quantity of tin which regularly attaches itself to the copper in the operation of tinning.

My five plates and a pot, scraped and weighed accurately, came from the operation with the following augmentations, which I shall specify here in arithmetical order, so that the differences may be more easily remarked,

A pot, having a surface of 144 inches, had acquired - - - - - - - - - - - - 140 grains.
The first plate, of an equal surface, 144
The second - - - - - - - - 178
The third - - - - - - - - - 200
The fourth - - - - - - - - 208
The fifth - - - - - - - - - 230

We see by this account that the tin applies itself to the copper in a very variable manner; but the attraction of the copper for the tin being equal in all the points of the superficies, this difference of weight depends upon the more or less powerful pressure which the workman employs in order to remove the excess of tin; whence it results, that the workman has it in his option to tin one piece in a richer manner than another. We ought not, however, in this second operation, to judge in the same manner as in the first, for he may, for his own interest's sake, press the tinning as much as he will, without doing any injury to his work; since it is evident that the portion of tin, which adheres only to the tin itself, melts, and

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and falls to the bottom of the fat at the first impression of heat, whilst that which adheres to the copper (and it is in this that the tinning consists) cannot be fused by so low a degree of heat.

We see also, that a good tinning, which is not uselessly overcharged, consumes only a grain of tin *per* square inch; that the medium quantity is commonly a grain and a half; and that, finally, in order to preserve our utensils from verdegris, we are obliged to sacrifice two pounds and a half of copper for the purpose of applying to them one pound and a half of tin.

The tin for which the brazier demands to be paid is not merely that which he applies to the copper, but also that which he loses in the furnace and in the operation of the rubbers which he employs for the tinning. The scrapings of copper which he collects cannot be considered as an equivalent for the tin which he employs, because, not being pure copper, he cannot sell them for more than fourteen or fifteen quartos * the pound, a price always very inferior to that of copper, and even of tin. This difference proceeds from the circumstance that these scrapings form a compound of copper, brass, tin, and lead, and the founders consequently can employ them only for augmenting the mass of those large pieces of cast metal which do not require to have the brilliancy of copper or of brass.

On the Duration and the Causes of Destruction of Tinning.

The tinning with pure tin has a silvery white colour; and if some vapour impairs its brilliancy, it becomes a little yellowish.

The tinning with a third, a quarter, or a half part of lead, in short the old tinning, has a more brilliant as-

* About eight-pence.

pect,

pect, its colour approaches to that of glass containing mercury. This tinning is very different from the former, and the workman distinguishes at first sight the tinning which contains lead. Let us now examine the causes which destroy the tinning, and the risks to which our health is exposed by the tinnings which contain, according to the custom of braziers, a third part of lead.

The causes of this destruction are of two kinds.

The first is the erosion to which the tinning is exposed from the friction with metal or wooden spoons, which the cooks use for stirring the matters which are prepared in boiling fat, &c. but still much more from the daily scouring with sand.

The second depends upon the solution which the tin may experience from the acids of vinegar, of lemons, of currants, &c. Let us return to the first cause.

There are detached from a too thick tinning, during the first days of use, some small drops of metal, which fall by their own gravity to the bottom of the aliments, and which rarely, or at least in very small quantity, are transferred from the pot into the dish, because it is equally rare that the cook does not perceive them. If this metal, which is in the form of small shot, comes upon the table, it likewise rarely happens that it is swallowed, because the tongue discovers and rejects it; and thus very little of it ever comes into the stomach. But, finally, whether it be swallowed or not, we have sufficient information to appreciate the danger which might result from it. No one has yet complained of these small metallic grains any more than of the leaden shot which are found in the pieces of the game which we eat.

A pot freed from all the superfluities of its tinning, which is not generally done with all, has no more particles which could mix with the aliments, excepting those which

which the iron spoons might detach from it, when farinaceous matters, herbs, &c. are fried in it. And even these particles are in such small quantity and so insignificant, that their existence may really be doubted. But admitting that they exist, it must however be agreed that, being distributed in a mass of aliments that is to be consumed by five persons at least, not the tenth part of a grain will be introduced into the stomach of each.

Suppose now that the tinning has been made with one half lead, which is the poorest tinning, the lead which will then come to the share of each person will be the twentieth part of a grain. What can we now have to fear from the twentieth part of a grain of lead, when we are in the habit of swallowing, in leaden shot, forty, nay a hundred times that quantity, without finding ourselves incommoded by it.

Arsenic, alloyed in the porportion of a fifteenth with tin, ceases to be a poison, as Bayen has proved. What then, I repeat, can we have to fear from a few particles of lead alloyed with tin?

The tinning of a pan that has a surface of a foot is not destroyed by the friction with the spoons in more than half of its surface, for the area of the bottom, compared with that of the lateral parts, is nearly in this proportion. In a house where the cook has any regard for the health of the family, they do not wait till the whole of the bottom of the pan is become bare, before they have it new tinned. The tinning of this utensil is always made with a third part of lead, because a larger proportion would too much impair that brilliancy to which the cook is accustomed in this article. The brazier therefore, who wishes to keep his custom, will deviate as little as possible from this proportion.

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The tinning of this utensil, which is employed daily, lasts at least a month and a half, according to the calculation made by braziers and cooks.

The tinning with tin and lead does not leave more than a grain to the inch of copper, because the alloy being more fluid than if it were merely tin, it is wiped cleaner off with the scrubber.

If the bottom of this pan has lost all its tinning in forty-five days, it has lost about seventy-two grains of its weight, of which a third is lead, that is to say twenty-four grains. If we now divide these twenty-four grains by forty-five days, we shall find that there has been detached from it $\frac{24}{45}$ of a grain per day, or half a grain of lead alloyed with tin; and finally, dividing this half grain between five persons, each will receive only a tenth of a grain. But in order that this shall take place, we must also suppose that the daily scowering has not detached from the bottom of the pan a considerable part of its seventy-two grains of tinning; which is contrary to all probability. It must therefore be admitted, *that if the tinned copper pans caused fatal accidents, these accidents are owing more to the copper than to the tinning of the utensil, which the poor have not always the means of having tinned as often as they might wish.*

It results from all that has been said, that the lead which the aliments cause to detach itself, even from the worst tinning, amounts to so very small a matter, compared with the shot which is so frequently found in the game that we eat every day, that it would be alarming ourselves without any reason, to fear the accidents that might result from it; whence I conclude that the terrors, which are endeavoured to be excited under this first point of view, are at least without foundation.

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We shall now proceed to examine the tinning with regard to its solubility, and ascertain by actual experiment in how far we have reason to apprehend the results of this solution.

Of Tinning, considered as an Alloy soluble in the Acids which enter into the Composition of the Aliments.

I caused eight pots, of the capacity of about twenty ounces each, to be tinned; the tinnings being prepared in the following order.

1. Of pure tin;
2. Of tin with five *per cent.* of lead;
3. ——— with ten *per cent.*
4. ——— with fifteen *per cent.*
5. ——— with twenty *per cent.*
6. ——— with twenty-five *per cent.*
7. ——— with thirty *per cent.*
8. ——— with fifty *per cent,*
9. Of pure lead.

These eight tinned pots were placed upon the same furnaces with a pound of red vinegar, which was boiled in them till the quantity was reduced to one-half.

The vinegar of each pot was then poured into a mattrass, where it was kept for forty-eight hours, in order to leave the molecules which rendered it turbid time to be deposited. Each sediment was separated, washed several times with clear water, and afterwards kept moist in the same vessel.

The acetous liquid which belonged to these eight sediments was diluted with a quantity of pure water equal to the loss which it had undergone by the boiling, and each liquid was afterwards divided in two mattrasses.

From this operation resulted three classes, of eight mattrasses each, which contained,

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The first and the second, the vinegar diluted with pure water, and divided in two bell-glasses;

The third, the washed and moist sediment which belonged to each pound of vinegar.

I afterwards threw into each mattrass of the first class about four ounces of solution of sulphate of potash.

Into each mattrass of the second class I put about four ounces of hydro-sulphurated water.

And into each mattrass of the third class, an equal quantity of the same water.

Let us now see the results of these mixtures.

When a liquor, such as wine, vinegar, &c. contains lead in solution, the sulphate of potash precipitates it in the form of a white powder, of which 136 parts constantly correspond to 100 parts of metal.

When a liquor contains lead, copper, and tin, the hydro-sulphurated water manifests the presence of each of these mixtures by the different colours, and separates them with the greatest accuracy.

When a sediment contains one or other of these three metal, its colour becomes extremely dark.

The first class did not produce any white powder; it therefore did not contain lead.

The second gave a light clear brown sediment, which indicated the presence of tin.

The sediments of the third class did not change their colour, whence I inferred that they did not contain any metallic part.

From what has been said it must be inferred, that vinegar boiled in tin pots, tinned with alloys more or less charged with lead, does not dissolve any of the latter metal, but only a very small quantity of tin. It is this that announced itself in the precipitates of a light brown colour, which we saw in the mattrasses of the second class.

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The sediments of these eight experiments contain therefore nothing of a metallic kind: it was of importance to be assured of this, because the tartar and the selenite, which formed the greatest part of them, would very well have been able to precipitate and carry with them the lead which the vinegar might have dissolved.

These experiments were repeated in the same pots, with very strong white vinegar, such as is used in the Royal Laboratory, and in that of the general hospital.

The vinegar was boiled in each pot, and it was evaporated till it was reduced to a fourth; after it had been taken out of each pot, diluted with pure water, and treated as in the preceding experiment, it was subjected to the same examination, and the results which were obtained with it perfectly confirmed the first. But these last experiments presented a peculiarity which did not appear in the first, because the vinegar was not equally strong. It consists in the circumstance that the tinning of the pots appeared after these last experiments of so leaden a colour, that it excited my curiosity, and induced me to press it with my fingers, in order to see if any thing would be detached from it. I found, in fact, that a grey powder was separated, which I collected with all possible care. This powder was nothing else than lead divided into molecules, so impalpable that it could not precipitate itself entirely in the space of twenty-four hours. I judged, from the mere appearance, that these sediments were the more voluminous according as they approached nearer to the tinning No. 8, which was the most charged with lead; however, the most remarkable of these sediments did not contain quite the weight of half a grain of it.

After having well distinguished this powder, I had still occasion to make a curious observation. I remarked that the

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the leaden colour of the tinnings was lighter after the action of the vinegar, in proportion as they approached nearer to the No. of pure tinning; so that with a little practice, and having before our eyes pieces of comparison, we might easily indicate the degree of alloy of a tinning.

But the most interesting circumstance is the figures formed by the vinegar upon the fine tinning: they present concentric zones, interlaced in one another, of the diameter of a *peseta* *, touching each other at their circumferences, the lights and shades of which form so striking a contrast, that, whilst they delight the eye, they may at the same time serve to indicate the tinning which is made with pure tin. As I obtained the same figures in another pot tinned with pure tin, in which I had boiled vinegar, I conclude that we may, by means of this solution, ascertain whether any tinning is fine or not.

On reflecting upon results so unforeseen as those which I have just recorded, and which prove so clearly that lead, which is ordinarily so soluble in vinegar, is not at all so when it is alloyed with tin, I shall now say, that theory ought to have led me to foresee or discover them. It is an incontestible fact in chemistry, that tin is infinitely more disposed than lead to become oxydated and dissolved. It is equally well known, that if tin enters into a solution of lead it gradually precipitates the latter, by depriving it of the oxygene which served as intermediary to its solution, and restoring it by this means to the state of metal.

Such is the origin of the black powder of which I have spoken. The vinegar, in the first moments of its application, may very well dissolve some atoms of lead, but

* This is a coin of about the diameter of a shilling.

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the tin takes away from them the solvent with much rapidity, and precipitates them to the bottom, without their being able to enter anew into solution.

But it will be said, if the lead can by solution, and the precipitation consequent upon it, separate itself from the tinning, who can assure us that this powder will not come to mix itself with our aliments, and occasion colics?

To this objection I shall answer, 1st. that in the catalogue of dishes invented to flatter our taste, there is none which is prepared with a pound of the strongest vinegar, boiled and evaporated till it is reduced to a fourth, in a pot tinned with equal parts of tin and lead; 2, that if fashion should introduce the use of such a sauce, it would be very improbable that the cook should consider it an improvement to press the metallic particles with his fingers, in order to incorporate them with it. Thus we may be very easy with respect to our aliments, as long as such a mess is not introduced, and the cooks do not think of such an experiment.

I must still mention an anomalous circumstance, which I have not yet had time to examine.

In the first experiments which I made with the vinegar, No. 8, tinned with an equal part of lead, communicated something to the vinegar; but as this phenomenon did not occur again in any of the subsequent experiments which I made with the pots, I conceive that this isolated result ought not to invalidate the inferences with which I am about to conclude this article, and the more so as they are confirmed in all their parts by the soundest chemical doctrine.

It results then, from all these experiments, that the solution of the lead of the tinnings is a circumstance which we have little reason to fear in our kitchens. It will soon appear,

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appear, that in order that this metal should dissolve in the vegetable acids, it would be requisite that the kitchen utensils should be of pure lead, or tinned with this metal alone. It has already been seen that the last means was impossible; and it is not to be presumed that the first is ever employed in our domestic establishments.

The glazing of ill-baked pottery is assuredly much to be dreaded, but tinning surcharged with lead is not so; or it must be proved to be the case by facts subversive of the best established truths of modern chemistry.

The law which enjoins the mixture of lead with tin for tinning is a wise one, like all those which emanate from so enlightened an administration. The pewterer's art ought not to be confounded with that of the brazier. Lead, by its nature, is not adapted to secure us against the dangers of copper, and tin, which the arts have chosen for this purpose, may be employed without alloy. However there are articles which depend upon the brazier's art, to which it would be, if not impossible, at least very difficult to apply the tinning without the aid of four or five parts in the hundred of lead. Such are the chocolate-pots and brass utensils which cannot be tinned so well with pure tin; such are the moulds which are used by pastry-cooks and confectioners; such are the articles which present many entering angles, alembics with narrow necks, coffee-pots, and other small utensils, which, besides that they are not in such general use as sauce-pans, are not exposed to lose their tinning, and still less to occasion any danger to the health of those who use them.

Tin runs better with the aid of lead, and it is applied more easily to all the interior part of utensils where the eye cannot direct the hand of the workman.

Kettles

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Kettles for boiling water, the bottoms of which are destroyed more speedily than the rest, coffee and chocolate pots will undoubtedly be sooner spoilt, if the bottom is not strengthened by a thicker layer of tin. This precaution, which greatly prolongs the duration, exempts the poor from the necessity of having these utensils often renewed. But new pots or kettles ought not to be sold with this additional tinning, for the buyer would then pay for, as copper, what is not such. Every one may, after having purchased these articles, have them strengthened after his own manner, especially when they are tinned and marked according to the law. No one can then oppose a custom generally established, as there will be no reason to find fault with it. These additional tinnings ought to be made with three parts of tin and one of lead.

On Pewter.

I thought it would be useful, under the existing circumstances, to examine pewter with regard to its solubility in the vegetable acids which are employed in our kitchens.

I had several vessels cast under my own inspection in the following order:

No. 1, pure tin.
2, - - - - 95 - lead - 5
3, - - - - 90 - - - - 10
4, - - - - 85 - - - - 15
5, - - - - 80 - - - - 20
6, - - - - 75 - - - - 25
7, - - - - 70 - - - - 30
8, - - - - 50 - - - - 50
9, - - - - - Pure lead.

These nine vessels were filled with boiling vinegar and kept for three days. The vinegar of the eight first vessels was tried by means of the sulphate of potash; it did not present the slightest portion of dissolved lead. The ninth was surcharged with the latter metal; but hydrosulphurated water discovered to me the tin which was dissolved in the eight first liquids.

I repeated these experiments three times with vinegar of different strength, and I obtained the same result. The tin, which is always more soluble and more easy to be oxydated then the lead, easily suffers itself to be attacked by the vinegar; but the lead not at all, and this for reasons which I have explained in speaking of tinning. It is also for this reason that the vessels, after the vinegar has been kept in them, appear of a leaden colour. This surface, denuded of tin, appears to abound more with lead than the piece does in its thickness, but the slighest friction detaches the light stratum which is formed at the surface, and restores the vessels to its original state.

The celebrated Bayen found that a plate of pure tin, which had been used every day for two years, had not lost more than four grains of its weight. Tin alloyed with lead is harder than pure tin, and consequently less subject to mix particles of its substance with our aliments. What ought we, or what can we, then apprehend from this pewter? is it perhaps the particles of metal which might be detached from it by the motion of the knife and fork? This is a groundless terror. With regard to its solubility in the alimentary acids, we know very well that the most innocent of metals constantly protects us against the dangerous properties of the other.

Vauquelin, at the suggestion of the committee of weights and measures in France, who wished to know

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to what extent lead might be mixed with tin, undertook an enquiry similar to mine, which he has published in the thirty-second volume of the *Annales de Chimie*, p. 243. It will there be seen, that with the exception of some particular facts, which proceed undoubtedly from the difference of the vinegars of each country, his results are entirely conformable to mine.

Accordingly, I shall apply to the pewters the inferences which I have deduced from my inquiries upon tinning, and shall assert, that, if the fears which some have endeavoured to excite with respect to the use of pewter are entirely destitute of foundation, the necessity of introducing innovations in the pewterer's art is not substantiated; and that even if this art were capable of being improved with regard to what concerns health, we ought never to seek for this improvement in alloys which all Europe has not thought fit to adopt; for there would still be a number of other alloys which might be tried before having recourse to a metal so soluble and so unmanageable as zinc is in the operation of tinning.

Let us now cast a glance upon the alloys which are in use among the pewterers, in order to ascertain their relations with that which we have just analyzed. Pure tin is that which constitutes the first quality, and it is that which is employed for making vessels to hold ices, sherbet, &c. in use in the houses of the opulent and those who will have every article of the best kind.

The second quality serves for making jugs and plates, of every kind, in houses where a great quantity of metal ware, and such as will last for a long time, is required. It is composed of an ounce or an ounce and a half of lead to the pound of tin, which amounts to 8 or 8½ per cent. of lead. If the fine tin costs 16 reals

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the pound when wrought, this latter, which is almost fine, sells commonly for 14 or 15 reals.

The third quality, which is called the *regulation-standard*, is composed of three ounces of lead to the pound of tin, which amounts to 15 or 16 per cent. This tinning in employed for sherbet-vessels, caraffes, saucers, and other utensils used in serving up lemonade. Its price is about 12 reals.

The fourth quality, or the common tinning, is composed of four ounces of lead and sixteen ounces of tin, which makes twenty per cent of the first metal; it is employed for making scrutoires, sand-boxes, spoons, candlesticks, surgical utensils and various small articles used for domestic purposes. The price of this tinning is less than that of the other, but it is regulated more by the workmanship than by the weight of the article.

We see from this sketch, that the poorest tinning, such as that of 20 per cent, is never employed in the fabrication of the utensils which serve for preparing and preserving our aliments and drinks. But, finally, even though a dishonest pewterer should employ it, his alloy can never be injurious to health, since vinegar may be kept in vessels alloyed with 33 or 50 per cent of lead, without its being possible to detect a sensible quantity of this metal in it. Before porcellain was in use, the luxury of our forefathers consisted in possessing an immense quantity of pewter. It has never been asserted that this metal, more or less alloyed, has been prejudicial to their health, or shortened their days. The history of medicine does not present any authentic fact to prove that the alloy of tin and lead merits the sentence of proscription pronounced against lead and copper.

TO BE CONTINUED IN OUR NEXT.

Experiments

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Experiments and Reflections on the Apparent Repulsions between some Fluids; observed by M. DRAPARNAUD; *and detailed in a Memoir inserted in our preceding Volume. By* DR. JOACHIM CARRADORI DE PRATO.

From the ANNALES DE CHIMIE.

THE observations, which Citizen Draparnaud relates in the *Annales de Chimie* * of Paris, are not new; and the consequences which he deduces from them are false. Several years ago † I observed that some fluids are driven by others upon the surface of water; and I have proved that these repulsions are only apparent, and that they proceed solely from the different degrees of attraction, which these fluids have for the surface of the water. Several times, in different journals ‡, and particularly in my replies to Prevost §, and in some letters written to Professor Brugnatelli ‖, I have insisted upon the true explanation of phenomena of this kind, proving by decisive experiments that these motions, which are believed to be the effect of a repulsion, proceed all from the same principle, namely, *the attraction of surface;* from whence it results that one fluid being attracted more than another, the other must necessarily retire from the surface on

* Memoire sur les movemens que certains fluides recoivent par le contact d'autres fluides, an. II. No. 141. See vol. V. of the present series of this work, page 146.

† Giorn. Fisic. Medic. di Pavia, 1793, Ann. Chim. di Pavia; Opuscoli scelti di Milano.

‡ Giorn. Italiani, et Journal de Physique de Paris; Ann. de Chim. de Paris.

§ Ann. Chim. di Pavia, tom. XIX. Ann. de Chim. de Paris, No. 143. an. 12.

‖ Ann. di Chim. di Pavia.

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which it was extended, and obeying its own cohesion or force of aggregation become concentrated.

I have lately resumed this subject, and have presented it in its clearest point of view, in a memoir inserted in the eleventh volume of the Transactions of the Italian Society of Sciences, where I have demonstrated, in the strictest manner, that the attraction of surface is the cause of the pretended repulsions of some fluids upon the surface of fluids, and of some fluids upon the surface of solids.

Professor Brugnatelli, in extending my experiments on the attraction of surface, had already spoken of the repulsions recently observed by Citizen Draparnaud; for he had remarked that several fluids thrown by drops upon the polished surface of solids, repelled each other; namely, oil, spirit of wine, oil of turpentine, and ether *.

Citizen Draparnaud says now, that alcohol or spirit of wine drives water and other liquids from the bottom of the vessels, because there is a continual emission of subtle particles, which, forming an atmosphere, produce the repulsion of the water, as Prevost has said of odorous atmospheres; and according to him, all volatile bodies are capable of doing the same at the ordinary temperature of the atmosphere, for he is of opinion that they act mechanically, that is to say, by means of the impulsion of their emanations.

But let me be permitted to oppose to him some facts, and some reasoning, in order to elucidate the truth. Water indeed retires from the surface of the vessel to which spirit of wine is applied; but it is not true that it is driven by a repelling force. It is equally erroneous, that the space left by the water, in making this experiment, is perfectly dry, as Draparnaud says; but there succeeds in the place of the water a slight stra-

* Ann. di Chim. di Pavia, tom. XVIII.

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tum of spirit of wine, which soon evaporates. The water, as well as the other fluids brought together by Draparnaud, retire, because they are obliged to yield the surface to the spirit of wine, which has more attraction for it than they, and seizes it with more energy: thus left to themselves, they become concentrated. In fact, a drop or two of spirit of wine, poured at a moderate temperature upon a plate, for example one of porcellain, is seen to extend itself upon and cover the surface like a varnish; but this does not happen when a drop or two of water is poured upon it, because it has not so much attraction of surface. The integrant particles of the water, which have a greater affinity of aggregation or cohesion with each other than attraction for the surface of the supposed body, do not extend or dilate themselves in that manner.

It is so true that spirit of wine or alcohol attaches itself more strongly than water to the surface of vessels, that if we throw a drop or two of this fluid upon a porcellain plate, and after it has extended itself upon it, forming a kind of disk, pour some drops of water upon it and force them to take the place occupied by the spirit of wine, we shall see the water, unable to detach the spirit of wine, obliged to pass over it, and the alcohol remain always fixed upon the surface of the plate.

But I can produce an easy experiment, which is in direct opposition to the opinion of Draparnaud. I fixed in the middle of a porcellain plate a small ball of soft wax, and I formed a cavity in it with the head of a large pin; I then poured into this plate a quantity of water, sufficient to rise above the margin of this cavity, without penetrating into it. The vessel being thus prepared, I dipped a straw-tube into spirit of wine, and conveyed a drop of this fluid into the cavity of the ball, so as to fill it.

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it. Thus I brought it about, that a drop of spirit of wine remained surrounded with water and almost in contact with it, and remained also below the level of the water. It is certain that, if spirit of wine were capable of exercising an expansive force by means of its emanating particles, it ought to have produced it in this case; but I did not observe any motion of repulsion in the water which surrounded the drop of spirit of wine. The water remained still tranquil and immoveable, as if it had been close to any not volatile fluid.

But when the water had passed the margin of the small cavity in the wax, it rushed into it to find its level; and I observed the small bodies which floated upon the surface of the water remove themselves from the above-mentioned cavity while the water flowed into it. This proves, that spirit of wine has, like the other volatile fluids, the property of spreading itself upon the surface of water, before it mixes with it.

In fact, I have observed that spirit of wine, when applied to the surface of water contained in a cup in which a drop of oil is extended, drives it away, taking its place, and obliges it to concentrate itself. If likewise we apply a little cotton dipped in spirit of wine, or a drop of this fluid, to the surface of water upon which some small pieces of gold or silver leaf are floating, we see them remove themselves and fly off. These small bodies also sometimes remove themselves and fly off at the approach of a small bit of cotton dipped in spirit of wine to the surface of the water upon which they lie; but they do it feebly, and not with that celerity as when we approach to them a little cotton dipped in ether *, and this because the spirit of wine, both in the state of fluid

*. See my replies to Prevost, in which it is seen that ether is a fluid which approaches more than spirit of wine to the nature of the oils.

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and in that of vapour, as it applies itself to the surface of the water, has the property of spreading itself upon it, like the oily substances.

But if we previously apply to the surface of the water a drop of the milky juice of tithymal, then throw upon it small pieces of silver and gold leaf, and touch it as usual with a little cotton dipped in spirit of wine, or even pour a drop or two of this fluid upon it, we shall not see the small pieces of leaf that float upon it do as before, because the spirit of wine traverses the surface of water occupied by a fluid which has a greater attraction for it. The case is the same if we apply to the surface of the water any fluid, the most volatile and the most oily, when it has previously been occupied by the juice of tithymal; none has the power of driving it away; but this juice, as soon as it touches the surface of the water*, drives from it all the most volatile and the most odoriferous oils, and obliges them to concentrate themselves at the extremities of the vessel in the form of small spheres.

I ask, from what cause, if these repulsions are occasioned by the impetuous efflux of odoriferous particles, has the milky juice of tithymal, which is neither volatile nor odorous, the power of driving from the surface of water the most volatile and most odoriferous fluids?

However, if we gently place a drop of spirit of wine in the middle of a plate, and then moisten the plate with water in such a manner, that it approaches to a distance of only two lines from the drop, we shall see it, before it dilates itself, exercising a repulsion upon the water which surrounds it, especially if it approaches too near; and, in my opinion, this effect is owing to the vapours of

* Memoir on the attraction of surface, in Transact. of the Italian Society of Sciences, vol. XI.

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the spirit of wine, which act at a distance, not because the water is repelled by a mechanical motion, but because, when they strike the surface of the plate, they extend themselves over it, and expel the water from the surface.

If it then happens that the drop of spirit of wine begins to touch the water which surrounds it, we immediately see an agitation produced, by which the water is repelled with much vivacity, and the drop of spirit of wine, animated with a new expansive force, breaks its limits, extends itself, and causes the water to recede. Nearly the same is the case with a small piece of camphor. If we put a small piece of this substance upon a pretty large plate, covered with water to the height of a line, in such a manner that the piece of camphor can touch the bottom of the plate, we shall see the water in a kind of *contrast* around the camphor, and it will seem that an expansive force keeps the water at a distance. All this, in my opinion, is the effect of the attraction of surface of the spirit of wine, and of the oil of camphor with the water. In fact, the oil of camphor, solicited by the attraction of surface of the water, evaporates with astonishing celerity, and is consumed in a short time. The same is the case with the spirit of wine and the oil of camphor; they precipitate themselves upon the water, extend themselves upon its surface with surprizing speed, whence proceeds the dispersion of the water, and the adhesion of the spirit of wine to the bottom of the vessel. The accelerated evaporation of these fluids can be attributed to no other cause than to this force, namely, the attraction of surface, by which the cohesion of the integrant parts is overcome, and consequently the expansive force of the small volatile parts which compose those fluids augmented; but

I have

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I have elsewhere sufficiently explained these phenomena, relative to the motions of camphor upon water *.

A drop of volatile alkali or ammoniac, says Draparnaud, does not drive the water from the bottom of the vessels like spirit of wine, because the ammoniac has much affinity with water. But cannot we say as much, of spirit of wine? However, this repulsion ought to take place, when water surrounds a drop of ammoniac as near to it as possible, but without touching it, and yet this does not happen.

A drop of ammoniac in the middle of a stratum of spirit of wine does not repel it, nor produce the circle of recession; but a drop of spirit of wine in the middle of a layer of ammoniac repels it around, and forms the circle. This shews, according to Draparnaud, that the expansive force of the spirit of wine is greater than that of the ammoniac.

But I have remarked that ammoniac has no attraction of surface, or at least very little, with the bottom of the vessels, whilst on the contrary alcohol has a great deal. Let a drop of ammoniac be poured upon a plate of porcellain or on a piece of crystal, and also a drop of spirit of wine; the first remains concentrated, and the other dilates itself; thus we see why the spirit of wine repels the ammoniac upon the bottom of the vessels, and why the ammoniac does not repel the spirit of wine.

Besides, if the expulsion of the ammoniac depended upon the mechanical impression of the emanations of the spirit of wine, it could scarcely manifest itself, for the force of the emanations of the spirit of wine must be

* Medico-physical Journal of Pavia; Annals of Chemistry of Pavia; Select Treatises of Milan; and latterly in some letters written to Professor Brugnatelli; Annals of Chemistry of Pavia; and the Memoir on the attraction of surface, vol. XI. of the Italian Society.

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weakened by the force of the emanations of the ammoniac; and yet it manifests itself with the same promptitude as that of the water. It is also observed that some fluids almost equally volatile and odorous, applied one after the other to the same surface, repel each other. For example, the essential oil of turpentine repels naphtha, and ether repels the essential oil of turpentine. How could this happen if the opposite forces destroyed each other? But it happens thus, because the essential oil of turpentine has more attraction of surface than the naphtha, and the ether more than the essential oil of turpentine.

But there is an observation of Draparnaud's which deserves to be discussed. He has remarked, that ammoniac expels oil from the surface of vessels, though it expels neither water nor spirit of wine. I have, moreover, remarked that the mere approach of a drop of ammoniac to the surface of the oil produces in it an evident commotion, like blowing. It appears, therefore, that the emanations of ammoniac render themselves in this manner apparent to the eye, that is to say, by means of the expulsive power or the mechanical impulse exercised upon the oil.

I do not pretend, nor have I ever pretended, that there may not be emanations of volatile bodies capable of rendering themselves perceptible to the sight in this sense, but only to shew that several phenomena, which pass for effects of repulsion caused by the expansion of the volatile bodies, do not depend upon this cause, but that they are effects of attraction of surface, and that there are no means of rendering perceptible to the eye, as Benoit Prevost imagines, the emanations of the odoriferous bodies. But before we decide upon the effect of ammoniac upon oil,

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oil, we must pay some attention to these remarkable observations.

If we throw small pieces of silver or gold leaf upon the surface of oil contained in a goblet, and then approach a drop of ammoniac, we shall observe a commotion in the surface of the oil, and in the small pieces of metal which float upon it; if we apply the drop of ammoniac to the surface of the oil, the small bodies will recede still more, and we shall see this fluid diffuse itself upon the surface in the most visible manner, whilst it produces an agitation in it.

If we perform this operation upon water, that is to say, if, after having thrown upon the surface of water, contained in a similar vessel, very light bodies, as for example small pieces of metal leaf or raspings of cork, we approach or apply to it a drop of ammoniac, no motion will take place. The same will be the case if, in place of water, we use spirit of wine, or any other not-oily fluid; but, if in place of these floating bodies, there is a drop or two of oil upon the water, this will experience a commotion from it. If we approach the drop of ammoniac perpendicularly to the oil floating upon the water, it causes it to dilate when the whole of the oil is in the form of a drop; and, when it is spread out in the form of a pellicle, it divides and scatters it. If we squeeze a piece of orange peel over the surface of water, and afterwards approach to it a drop of ammoniac, we shall remark, at all the oily points with which the surface of the water is sprinkled, that a slight agitation takes place.

It seems therefore, according to these experiments, that ammoniac renders the emanations upon oil sensible to the sight, not by a mechanical impulsion, but by a physical

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physical action, since it does not manifest itself upon the other fluids.

It cannot be doubted, that the impulse or the expansive force of the ammoniacal emanations ought to act indiscriminately upon all bodies, and communicate to all the same impulsion, when they can move freely, and a drop of ammoniac approached to the surface of spirit of wine, because it is equally light, if not lighter than oil. I have moreover found that ammoniac, when approached to the smoke of a candle that is turned by the slightest breath, does not produce any motion in it: thus the effect of ammoniac upon oil cannot be attributed to a mechanical action.

But here is a proof which admits of no reply. If we throw raspings of cork upon water, and then approach a drop of ammoniac to them, no motion is produced. But if we take another quantity of cork-raspings, and having rubbed them between the fingers smeared with oil, throw them upon the surface of water in another glass, and again approach a drop of ammoniac to them, then all these small bodies will move in a surprizing manner. If we throw wheat-flour into another glass of water, the approach of the drop of ammoniac will not cause these small molecules to move, but if we throw into it the flour of almonds, which is oily, it will cause them to move, and to be precipitated to the bottom of the vessel. The same experiment, repeated in a thousand different ways, will always confirm my conclusion, namely, that the action of ammoniac renders itself sensible upon the oils, and upon all matters that are oily or impregnated with oil.

I think, therefore, that I have demonstrated, that the repulsion which ammoniac exerts upon oil, is not an effect

fect of the force of its emanations or vapours, and I believe that it ought to be attributed to the attraction of surface which ammoniac has, both in the fluid state and in that of vapour, with the oil itself, conjointly with a chemical attraction, which results from the changes which oil undergoes when it is exposed to the effluvia of ammoniac. This phenomenon is to be explained, in my opinion, in the same manner as that of a drop of water exposed in the middle of a stratum of water; that is to say, that the repulsive power which the ammoniac seems to exert upon the oil, proceeds from the expansion of the ammoniac, or of its vapours upon the oil, by means of the attraction of surface.

In fact, if we throw a drop of ammoniac upon the bottom of a vessel, and pour around it a very little oil, in such a manner that it surrounds the drop of ammoniac, spread out the oil with the finger, and approach ammoniac to it, we shall see the oil recede; but when it comes to touch it, we then see the drop of ammoniac break its limits, extend itself over the oil, and disperse it with astonishing celerity.

The ancients would have attributed it to an antipathy between the ammoniac and the oil; but these chimerical notions have vanished before the light of experimental philosophy. It does not appear that the repulsions between the different fluids can now be supported, after the laws of attraction of surface which I have observed *.

* See my memoir on the attraction of surface at the place cited.

Extract

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Extract of a Memoir of M. Payssé, *principal Apothecary to the Camp at Utrecht, on the Preparation of some of the Oxydes of Mercury in the large Way.*

By M. PARMENTIER.

From the ANNALES DE CHIMIE.

I HAVE formerly announced the details which I am about to present to the reader on the processes which the Dutch employ in the large way for preparing the red sulphurated oxyde of mercury and the red oxyde of mercury by the nitric acid. M. Payssé, to whom we are under this new obligation, does not lose an instant in availing himself of the advantages afforded him by his residence in Holland; he seizes every opportunity of visiting the manufactures which are so numerous in this country, as well as the cabinets of the curious which may serve for his instruction. The disgusts, the difficulties of all kinds which he has experienced in procuring admission into the work-shops, serve to demonstrate the ardour of his zeal for the sciences and the arts; but in the midst of the obstacles and inconveniences which meet the traveller in the way of his researches, he frequently obtains a compensation for the labours which he undergoes and the sacrifices which he makes, when he is so fortunate as to meet with some objects adapted to gratify his desire of adding to his knowledge, and enriching his country with the discoveries of the industrious nations whom he has occasion to visit. Such is the enviable lot of M. Payssé, who has already procured detached information upon a variety of interesting subjects; and how valuable that information is will be easily judged from the extract which I am about to give from the last memoir which this chemist has transmitted to me.

Red

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Red sulphurated Oxyde of Mercury.

This substance is prepared only in the manufactories at Amsterdam, the most considerable of which is that which belonged to the late M. Brand. M. Payssé was present at an operation in which about 400 kilogrammes (800 lbs.), divided in two apparatus, were prepared. He followed the details with all the attention in his power; and, after having compared them with those which M. Tukert has published in the fourth volume of the "Annales de Chimie," year 1790, p. 25, he found only very slight differences in them, so that the description of the Amsterdam author must be considered as very nearly accurate. The circumstances which he omitted are as follows. He has not spoken of the duration, or of the colour of the flame which proceeds from the combustion of the combination of the sulphur and mercury which is prepared beforehand and introduced into the apparatus. This flame, the disengagement of which is extremely rapid, presents the most varied colours, at first of a vivid dazzling white, elevating itself at least twelve decimeters above the dome of the furnace, afterwards yellow and white, orange yellow, blue and yellow, giving rise then to green, violet, and at length blue and green tinges; its disengagement is regulated towards the end by a kind of register of iron-plate; when it elevates itself no longer more than some centimetres, and its colour is of a fine azure or indigo blue, the apparatus is hermetically sealed and luted externally with a mixture of clay and sand.

It cannot be doubted, considering the loss which is sustained in the result of this operation, that the so multiplied tinges of this flame, the disengagement of which lasts about half an hour with 200 kilogrammes of matter, are owing to the union of the sulphur with varied proportions of mercury at different degrees of oxygena-

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tion. The 400 kilogrammes, or about 800 pounds of red sulphurated oxyde of mercury, are found reduced to 379 or 322 kilogrammes, or from 738 to 745 pounds, which makes a loss of from 27 to 31 kilogrammes.

In speaking of the vessels which are made use of in this operation, M. Tukert has also omitted to describe their exact form; the principal vessel is not a jar, but rather a kind of crucible, round which the heat circulates, and which is surmounted by an iron dome, through the top of which the matter is introduced, after the crucible has been heated to redness. The success of the operation depends essentially upon the manner in which the fire is conducted during the sublimation. The combustible which is employed is turf, and, as M. Payssé has observed, there is none better adapted than this, when the object is to obtain a constant and at the same time moderate heat; this uniformity of temperature, during the thirty hours that the fire is applied in the furnace, is undoubtedly one of the causes which contribute the most to the success of the operation. Experience also confirms this opinion, according to the testimony of the workmen.

The red sulphurated oxide of mercury being once prepared, a large quantity of it is reduced to powder, in order to be converted into the vermillion of commerce. This preparation is still a secret in the possession of the Dutch; and yet there is no chemical work in which the process for obtaining it is not described; they merely direct us to reduce the cinnabar to powder, to wash it in water, and then to dry it. This means, which M. Payssé has frequently put in practice, has indeed always given him as the product a fine red powder; but it must nevertheless be admitted that it is not equal in beauty and lustre of colour to that of Dutch manufacture.

China

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China furnishes painting with a kind of red sulphurated oxyde of mercury in powder (vermillion), which is in much higher estimation than the Dutch; its colour is the most beautiful red of an incomparable lustre; for some years past also the Dutch have been employed in imitating it. M. Payssé has seen some prepared, a very short time since, in the manufactures of that country, the process for which is another secret. This oxyde rivals that of the Chinese in beauty: he thinks even that in a short time it may be brought to the same degree of perfection.

Not having been able to procure any information respecting the means put in practice in order to imitate this particular preparation; suspecting however that the lustre of the sulphurated oxyde of mercury of the Chinese, as well as that of the Dutch, could be owing only to the more or less advanced state of oxygenation in which mercury exists in this compound; M. Payssé made an experiment: he took a hundred parts of Dutch red sulphurated oxyde of mercury; after having put them into a capsule of glass, sheltered from the rays of the light, he covered this powder with some cubic centimeters of pure water, using the precaution to agitate this mixture with a glass tube for the space of a month. After seven or eight days he saw the oxyde change sensibly, and assume a very pleasing tinge; during about twenty-five days the lustre of the red augmented gradually, and acquired the greatest beauty. Having perceived that the matter remained in the same state, and underwent no farther apparent change, he poured off the water, and dried the red sulphurated oxyde of mercury in the shade, and in a mild temperature. Having compared it in this state, when it was well dried, with that called the Chinese and that of the Dutch manufacture, prepared by their

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secret process, M. Payssé did not discover any sensible difference in either the beauty or the lustre of the red; so that this very simple experiment puts us in possession of a process of great advantage to the arts, particularly to that of painting, and of which the Dutch have long made a secret.

Wishing to know whether air and light alone could produce a similar effect on this sulpurated oxyde, M. Payssé disposed a hundred parts of the same substance, likewise in powder, in a vessel similar to the first, to the action of a bright light, for the space of more than a month: he took care, as in the former experiment, to renew the surfaces very frequently by agitation, in order to multiply the points of contact of this sulphurated oxyde with the air which served for its atmosphere; but instead of acquiring a more beautiful red, the sulphurated mercurial oxyde assumed a brick colour, inclining to a brown. There can be no doubt, according to this experiment, that the light has a very sensible influence upon this substance, and tends to reduce the sulphurated mercurial oxyde, by separating from it a portion of oxygene, as it does from most of the matters of this kind that are exposed to its immediate contact.

TO BE CONCLUDED IN OUR NEXT.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

Feeding Sheep with Potatoes.

MR. John Forster, of Royston, in Herefordshire, has made a very successful trial of potatoes in the feeding of sheep during the winter. While the weather continued open

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open and fair, the sheep were put upon turnips in the day, and home to the fold-yard at night, and had fresh straw given them. As soon as the frost prevented them folding upon turnips, trial was made of potatoes, which were put whole into troughs. The sheep ate very few for two or three days; after that time the only trouble was to keep them from running over the feeder. Three hundred ewes were supplied every morning with five bushels of potatoes, and fresh straw twice in the day. With this keep they did very well through the winter, sometimes on potatoes and sometimes turnips, as the weather permitted. The beginning of April the ewes and lambs were put upon three acres of Swedish turnips, which lasted them one month; they came home to the fold-yard every night. After that time they took the common field, and were folded every night through the summer. There was a bad fall of lambs that spring; some farmers lost their lambs in consequence of the ewes having but little milk, but Mr. Forster's fall of lambs was very good, 100 ewes brought him up 100 lambs, which were sold the following July for 14*s.* each, except forty of the best ewe's lambs, which were kept for stores. The May following Mr. Forster planted about five acres of potatoes, ploughed the land into one-bout ridges, spread long dung in the intervals, and planted potatoes on the dung; then, with a double-mould board plough covered up the plants, running a roll over the land to flatten the ridges. As soon as the plants were all up, a small swing plough was used to slice off a furrow from each side of the plants, which cast the mould into the middle of the interval, hand-hoed between the plants, and as soon as the weeds began to grow again split the ridges of mould with the double plough, which moulded up the plants completely. The produce two hundred bushels *per* acre.

Mr.

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Mr. Forster's turnips failing last winter, potatoes were given to his sheep with nothing more than fresh straw night and morning through the winter, and at Lady-day the ewes and lambs were allowed to be in better condition than any flock in the neighbourhood. This may therefore be considered as a fair trial of potatoes, as the sheep had no other succulent food whatever; besides what the seven score of sheep consumed, as many potatoes were sold as paid 5 *l. per* acre. The land was ploughed as soon as the potatoes were taken up, and drilled with wheat at nine inches; crop as good as any that grew the same year.

Method of forming Roads on Clay or wet Bottoms.

First throw the soil from the sides, leaving a groove in the middle for the materials, beginning with kid or brush wood plentifully, then stones and gravel: if the gravel be very sharp and good, there is no occasion to round the road. Even a concave surface is found to answer very well; but where the materials are tender, it may be better to round it a little, but not so much as is frequently done, being often dangerous, and hurtful to the road, by obliging the carriages to keep in one track.

Dyeing.

A new method of dyeing cotton a rose colour has been discovered by M. Bruchmann, of Berlin. For this purpose he employs wild plumbs and muriatic or sulphuric acid.

New Metal in Crude Platina.

M. Brugnatelli writes to M. Van Mons on the subject of the new metal discovered by Messrs. Fourcroy and Vauquelin

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Vauquelin in crude platina, (see the preceding volume of the present series,) that he had a long time ago obtained separately the substance which colours the solutions of platina. He diluted the solution of crude platina with eight or ten parts of water, and added a solution of muriate of ammoniac. The mixture did not at first become turbid, but after some minutes the sides and bottom of the vessel became covered with the red matter in shining particles.

Nickel.

M. Richter is at present occupied in a series of experiments upon nickel. In its pure state this metal is very malleable, nearly as brilliant as silver, and more attractible by the loadstone than iron. He asserts, that in the purest state in which it has hitherto been obtained, it still contains much copper. M. Richter has found a sure method of freeing it from this metal. The oxydes of the purified nickel are of a much more lively green colour than the ordinary oxydes, and their solution in ammoniac is of a very pale blue.

Metallic Oxydes.

M. Klaproth has found that the solutions of the metallic oxydes in the alkalies are as easily precipitated in the metallic state by other metals soluble in the same salts, as also by phosphorus, as the acid metallic solutions are. He has made a very ingenious application of this circumstance to the analysis of the ores of tin, according to the method which he has indicated in his *Beitraege*. In this process the tungstein is separated by zinc from the tungstate of ammoniac, in the form of black flakes.

Refractory

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Refractory Quality of Magnesia.

M. Giobert writes, that he has found that magnesia communicates to all the earths with which it is mixed a refractory quality. Glass-makers crucibles, formed of any clay which is not very ferruginous, to which a third or half of magnesia of Bandisaro is added, resist the action of fire in the most perfect manner.

List of Patents for Inventions, &c.

(Continued from Page 80.)

ROBERT RAINES, the younger, of the town and port of Hull, in the county of York, Tanner and Glue-manufacturer; for a method of making and manufacturing of hard glue from tail, fins, and other parts of whale-fish. Dated November 22, 1804.

HENRY CLAYFIELD, of the city of Bristol, Wine Merchant; for a method of finding out of certain processes for separating the alkalies of potash and of soda from their sulphates or vitriolic salts, and from their sulphates or combinations with sulphur, as in soapers black ash and other similar compounds.
Dated November 22, 1804.

JAMES SHARPLES, of the city of Bath, in the county of Somerset, Esquire; for certain combinations and arrangements of implements and mechanical powers, and certain principles and forms of tables useful for surveying. Dated November 24, 1804.

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THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. XXXIII. SECOND SERIES. Feb. 1805.

Specification of the Patent granted to EDWARD MARTIN, *of Morriston, in the County of Glamorgan, Gentleman; for his Invention for making of Pig and Cast Iron, of every Description, from Iron-Stone, Iron-Mine, and Iron-Ore, and of re-melting, preparing, and refining of Pig and Cast Iron, of every Sort, and for the making of such Pig and Cast Iron into Wrought or Bar Iron, by using raw Stone, Coal, and Culm, to be worked and made by Blast.* Dated June 23, 1804.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Edward Martin do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, and the method I use to make stone, coal, and culm to stand the blast, as follows; that is to say: To light the fire in the furnace, finery, or hearth, with free-burning wood; and as soon as the wood is sufficiently ignited, then to put on small quantities of raw stone, coal, or culm, free of dust

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(broken into the size of a common hen's-egg); to continue to feed the furnace, finery, or hearth, with raw stone, coal, or culm, till it is quite full of vivid fire, before any blast is introduced; then (in making pig or cast iron) to charge the furnace, in the common way, with due proportions of raw stone, coal, or culm, clear of dust (instead of coke or charcoal), with iron-stone, iron-mine or iron-ore, and lime-stone; then to introduce the blast, in a very gentle manner, for the first twelve hours; then to increase the blast gradually day after day, for the first week of blowing, till the furnace is sufficiently hot and burthened; and then to blow to any extent the machinery of the furnace is capable of bearing. And by keeping the furnace regularly and properly fed with materials, and by keeping up a sufficient blast, the process will be completed. And in remelting, preparing, and refining of pig and cast iron, of every sort, and for making such pig and cast iron into wrought or bar iron, the foregoing method of lighting and feeding the hearth or finery till it is full of vivid stone, coal, or culm, must be pursued before the finery or hearth is charged with metal, or the blast introduced. Then by charging with metal, and feeding the finery or hearth with raw stone, coal, or culm, (instead of coke or charcoal), and by introducing the blast in the common way, the wished-for success will be produced.

In witness whereof, &c.

Specification

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Specification of the Patent granted to ROBERT CAMERON, *of Rosamond-street, Clerkenwell, in the County of Middlesex, Engineer; for Improvements in Sawing-Machines, and for a new Method of working Sawing-Machines.* Dated September 30, 1784.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Robert Cameron, in pursuance of, and in compliance with, the said proviso in the said letters patent contained, and the purport and true intent and meaning thereof, and of his Majesty's said most gracious intentions, do declare (by this instrument in writing, under my hand and seal duly executed) that the nature of the said invention of making my said new-invented improvements in sawing-machines, and my new method of working sawing-machines, and the manner in which the same is to be performed, appears from the plan or drawing, and index or references thereto made and explained, and hereunto annexed.

In witness whereof, &c.

INDEX TO THE ABOVE PLANS.

Fig. 1, (Plate VIII.) in the above drawing is a section, lengthwise, of the principal operating parts of the machine, where A A is a moveable carriage, upon which the wood B to be cut is fixed. C C is the frame, in which is fixed the saws D D, and which, being moved to and fro saw the wood, which on the carriage A A, is moved towards the saws by means of the lever E, the ratchet-wheel and clicks F G and H, and the pinion and rack I and K.

The operation of the machine is as follows:

When the saw-frame C C is moved upwards, it moves the lever E round its centre O, and the click or pall G

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being hung at one end to the lever E, between the centre and that end of the lever which is acted on by the saw-frame, and the other end of the click laying hold of the teeth of the wheel F, when the saw-frame rises, the wheel F is moved round its axis, and by the pinion I working into the rack K moves the carriage towards the saws; then, by the descent of the saw-frame, there is so much of the wood cut as the carriage is advanced forward *per* stroke. The other click H, which falls into the teeth of F, being hinged on a fixed centre, hinders the carriage from being drove back by the saw-frame when it descends cutting the wood.

To the above general description of a method of stretching a number of saws placed near one another, and a method of holding the wood while sawed, which will enable any person acquainted with such sort of mechanism to construct a machine for sawing the vaniers. The principle of the method of stretching the saws here represented, consists in making the saws, or the ends of the saws, of different lengths, so as to stretch one set of saws above or beyond the place where the other set are fixed or stretched. An example of this method is given in the drawing, where D D represent the saws, which in this instance are in two sets of different lengths: they are all fastened at the lower end at L to the cross rail of the saw-frame. At the upper end they are stretched by wedges M and N, which are placed one above the other, so that the plates fastened to the ends of the saws, to form buckles or conveniences for stretching the saws, may not be opposite each other in the two sets of saws; by this means the saws admit of being placed near together.

Fig. 2 is a representation of the saws without the frame. A, is a side view of one of the short saws. B, is a side view of one of the long saws. C, is an edge-

view

view of a number of saws stretched in this manner; that is to say, they are fastened at the lower end by the piece D, which goes through all the saws, and is fastened to the cross rail of the saw-frame. The figure at E F shews the buckles or contrivances for stretching them at the top end. The method of holding the wood whilst sawed consists in fastening the plank, or other piece of wood, to be cut, sidewise, to the carriage, and likewise supporting it under the edge. In Fig. 1 the piece of wood B is fastened to the carriage by means of the instrument P Q, resembling a cabinet-maker's hand-screw. It is likewise fastened to one or more places by means of the instrument R and S, resembling a vice.

Fig. 3, is a cross section of the principal operating parts, where A A is the saw-frame. B B, sections of the sides of the carriage. D, is the end of the piece of wood to be sawed, which is fastened at the end by the instrument E E, referred to in Fig. 1, at the letters P Q. F F, is the instrument referred to in Fig. 1, at the letters R S, by which it is fastened at one or more places to the side of the carriage. G, is a piece going across the carriage, and supporting the piece of wood to be sawed under its edge.

Fig. 4, is a plan of the principal operating parts where A A is the carriage moving forward on the fixed frame B B, by means of the ratchet-wheel, pinion, and rack above described. C C, represents the end of the saw-frame. D, is the piece of wood to be sawed, which is fastened to the carriage at the end by the instrument E, referred to in Fig. 1, at P Q, likewise at F F, by the instrument referred to in Fig. 1, at the letters R S.

The above examples of the method of stretching the saws I likewise apply to the sawing of thin boards in general. I have described them as methods which I practise,

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tise, although in vanier sawing, a number of saws, placed near one another, may be stretched by a wedge or other mechanical instrument going through a number of saws. And in order that it may stretch them all equally, it will be necessary to be at great pains to adjust all the saws to their proper lengths, which may be done by stretching all the saws separately by the same weight, and by means of a gage adjusting them to their lengths. Or vaniers may be sawed by a single saw, and a contrivance in the carriage to regulate the wood sidewise, and a contrivance in the saw-frame to regulate the saw sidewise, so as to perform as many operations on the same piece as may be found necessary; which last contrivance may be used with one or any convenient number of saws. Very narrow vaniers may likewise be sawed by means of circular saws, which are fixed on an axis, and move without it in one direction.

My new method of working sawing-machines for sawing of wood or stones consists in applying the power of the steam-engine to work these machines, either by direct application of the powers of the engine, or by raising water to turn a wheel, which works the sawing-engine.

My improvements in sawing-machines consists in adapting these machines to the sawing of mahogany, and other hard woods used for vaniers, and to the sawing of thin boards in general.

The methods by which I saw mahogany and other hard woods into vaniers, consists in fixing the wood to be cut on a moveable carriage, and in fixing a saw, or a number of saws, in a frame, which being moved to and fro saws the wood which on the moving carriage is brought forward to be cut.

Specification

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Fig. 3.

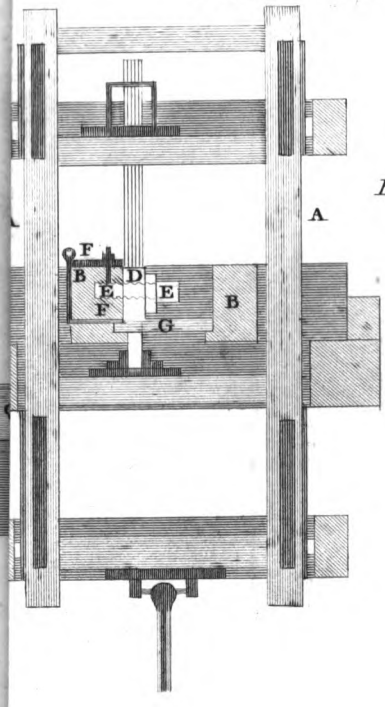
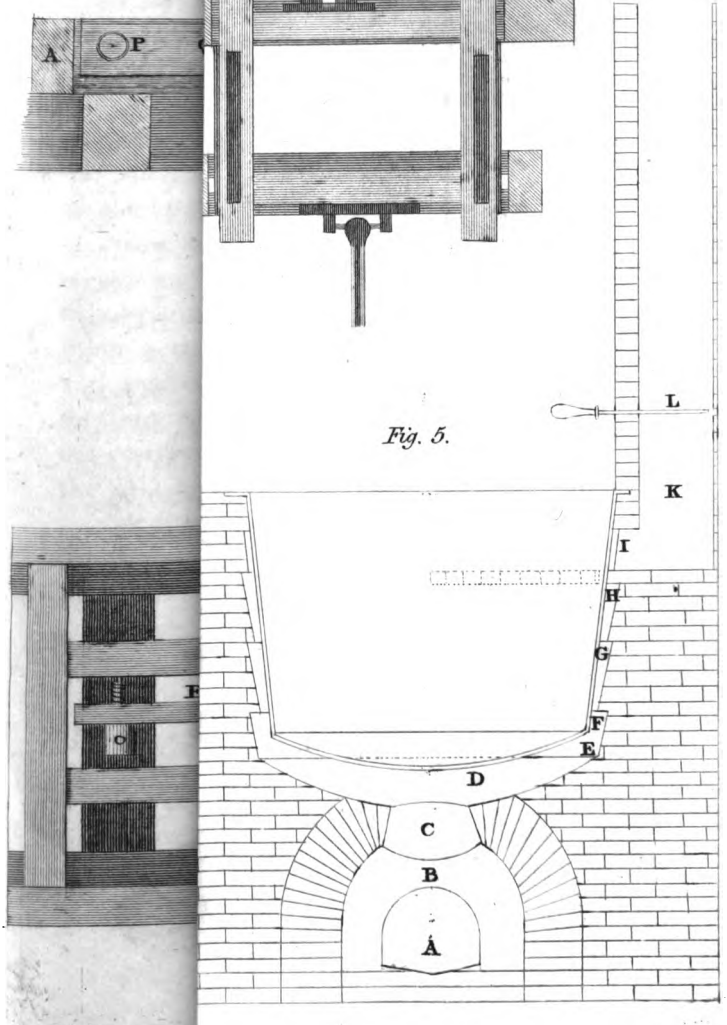


Fig. 5.



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Specification of the Patent granted to JOHN SWIFT SAXELBYE, *of the Town of Derby, in the County of Derby, White Lead Maker; for a Method of making White Lead different from the Methods now practised and used, and without the Aid of Horse-Litter or Tanner's-Bark, or both of them.* Dated May 14, 1804.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Swift Saxelbye do hereby declare that my said invention is described in manner following; that is to say: Instead of applying heat, or causing an increase of temperature (in the pots or vessels containing the acid, and the metallic lead intended to be subjected to the process by which white lead is made), by means of horse-litter or tanner's-bark, or both of them, or by means of the gradual decomposition or change which takes place during the decay and rotting of those, or any other remains of organized bodies, I do avail myself, and make use of that augmentation of temperature or sensible heat which is produced and communicated by the combustion of fuel. And I do regulate and manage the said heat so that the same shall be kept within the proper limits, and shall be sufficient to cause the intended change or oxydation of the lead in an effectual manner, without causing the acid in the pots to be volatilized to a greater degree than is necessary for the intended purpose, and the particular means by which I do perform the same are described as follows: I make my fire or fires in a proper stove or receptacle, with its apertures, flues, chimnies, registers, dampers, and other parts which require no particular description, because it will be sufficient if the construction thereof be such as that the

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the operator or attendant shall have it in his power to manage and regulate the fire and the communication of heat in the usual manner. The said stove is so built or placed as to communicate heat as generally and uniformly as may be to a room or space constructed of such materials and dimensions as to receive the pots containing the usual charge of metallic lead and acid, and to admit of the same being regularly placed and disposed, and shut up, but that none of the smoke, vapours, or other immediate exhalations from the fuel should be admitted within the said room or space. And I do not only cause the quantity of heat to be regulated by an attention to the quantity or weight, and the nature or kind of the fuel to be consumed in any determinate time; but I do still more completely enable my operator to keep the temperature at the requisite degree by introducing or inserting one or more thermometers into the room or space containing the pots, but leaving their scales or graduations so placed as to indicate any changes of heat that may take place in the said room or space. And the said thermometers may be of any proper and fit construction, according to the well-known methods, wherein mercury or any other fluid is used, or wherein all the parts are solid, as in the instruments called pyrometers. And moreover, and for the purpose of preventing any wasteful or pernicious excess of heat, I do construct and make, at some convenient place in the upper part of the said room or space, a valve, or shut or aperture, capable of being opened to let out some of the heated air or elastic fluid when the same is requisite to be done. And I do connect with the cover or lid, or stopper, of the said valve, either the arm of a float, supported by the mercury of a large thermometer, or else the arm of a pyrometrical apparatus, or expansion bar, so that by an action,

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action, which every mechanical man acquainted with subjects of this nature will readily apprehend, the increase of temperature shall cause the said valve to be opened, and, contrarywise, a diminution of temperature shall suffer the same to be again closed. And I do find, by experience, that the temperatures best calculated for these operations are, that the said room or space should be kept between ninety and one hundred degrees of Fahrenheit's scale during the first ten or twelve days, and from one hundred to one hundred and ten for the next eight days; and that the heat be regularly and equally increased about ten degrees for each successive portion of eight days until the expiration of about six weeks in the whole from the commencement of the operation, or until the vinegar or other acid liquor shall have been evaporated; at which period the pots are to be taken out, and the white lead separated and ground for sale as usual. Lastly, I do in some cases make use of water or steam as the medium of communication through or by which the heat, so as aforesaid produced, is transmitted into the said room or space containing the said pots; and in these last-mentioned cases the said water or steam may be still farther and usefully employed for general purposes that constitute no part of my said invention, though the economy of the said invention may be thereby in such cases promoted. And I do then, if needful, make thermometrical observations on the temperature of the said water or steam, in order the better to regulate and govern my fire, and the general process of my said invention dependant thereon.

In witness whereof, &c.

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Specification of the Patent granted to EDWARD GREAVES, *of Sheffield, in the County of York, Razor-Manufacturer; for Improvements on Razors.*

Dated August 4, 1804.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Edward Greaves, in compliance with the said proviso, do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, is particularly described and ascertained in the above drawings, sections, plans, or plates, and the following description thereof; that is to say:

Fig. 1, (Plate IX.) represents the razor with the spring and catch. *a*, is the blade; *h*, the handle; *b*, the catch; and *i* is the spring. A pin passes through the hole of the catch at *b*, and is rivetted in the handle *h* upon this pin as a centre; the catch *b* is moveable. Also the spring *i* presses against the catch at *g*, by which means the return end thereof is pressed in the notch *f*. In this figure the razor is represented as shut, and is kept so by the pressure of the spring *i* against the end *g* of the catch *b*.

Fig. 2, shews the blade *a* with the notches *c d e* and *f*, and also the catch *b*, together with part of the handle *h*; and the razor in this figure is represented without the spring, and the catch not in use.

Fig. 3. In this draught is shewn the blade, the handle, the catch, and the spring: the razor is represented in the position in which it is generally used. In this position the catch *b* secures the blade *a* by the pressure of the spring *i* against the end *g* of the catch *b*.

Fig.

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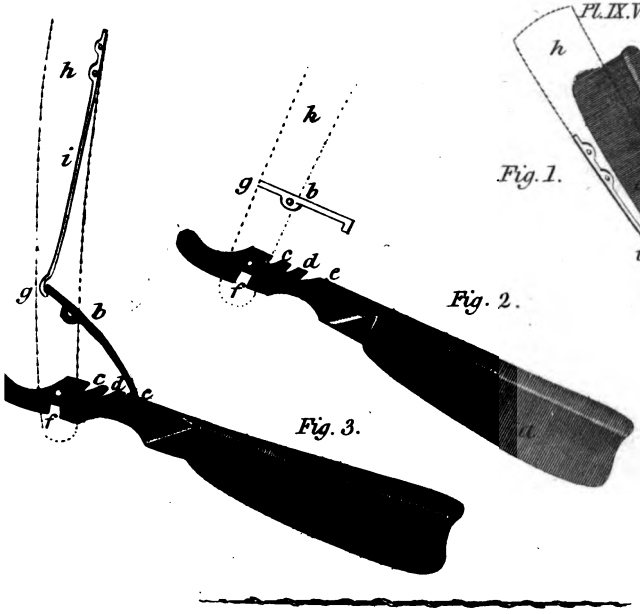

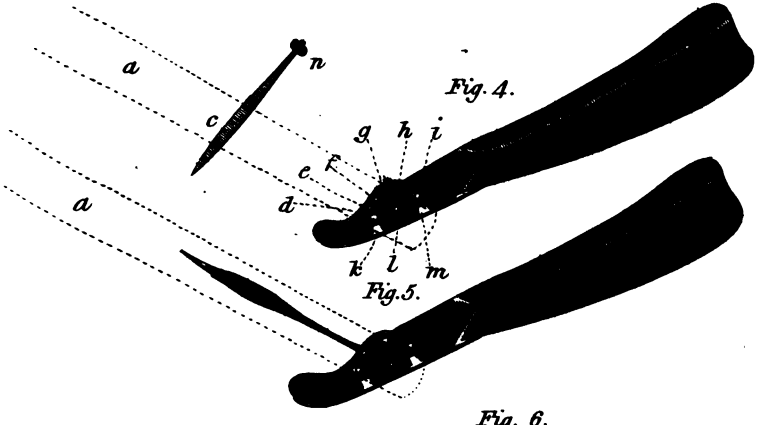

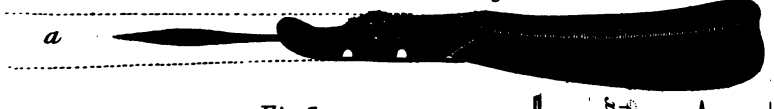

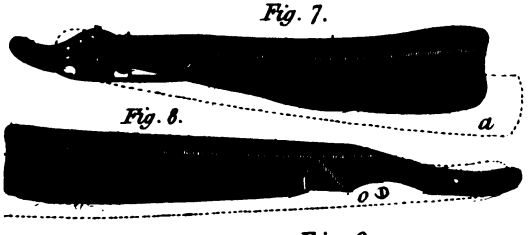

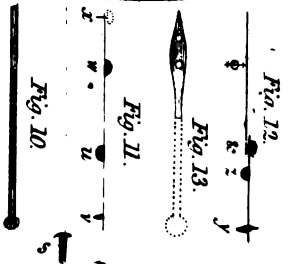

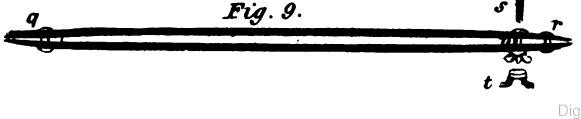

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Fig. 4 represents the handle *a* and the blade *b*; also the spring *c d e f g h*, &c. are holes in the blade tang. *k* and *m* are hollowed in the tang in which the pin *n* of the spring *c* slides when in contact with the tang of the blade.

In Fig. 5 is shewn the blade *b*, so situated (with respect to the handle) that the pin *n* of the spring *c* is in the hole *f*.

In Fig. 6 is seen the pin *n* in the hole *d*.

Fig. 8 shews the pin *n* of the spring *c* in the hole *i*. In the positions of Figs. 5 and 6 the blade is secured in those positions by the pin *n* of the spring *c* in the hole *f* in Fig. 5, and in the hole *d* in Fig. 6. Also the blade is shewn in Fig. 7, where the blade is represented as shut in the handle; the pin *n* secures it in that situation by being in the hole *i*. Fig. 8 is the profile view of a razor, in which the blade may be secured in any position (with respect to the handle) by means of a screw and a nut. The head of the screw is denoted by the letter *o*.

Fig. 9 shews the handle, &c. of the razor viewed edgewise. In this representation *g* is the rivet at the end of the handle, and *r* is the rivet passing through the tang at the other end; *s* is the screw, and *t* is the nut. In this figure at *p* is shewn the nut and the screw in use.

Fig. 10 is a spring, which may be substituted for the spring *c*, in Fig. 4.

Fig. 11 is a section of the spring in Fig. 10, and is a pin passing through the slit in Fig. 10, to prevent the spring rising above the surface of the handle, and the slit in Fig. 10 allows a motion in that spring. At *u* a spring passes through the hole and the handle, and a person by pressing upon the projecting piece at *w* will raise the pin *v* out of the hole in the tang of the blade.

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Fig. 13 is a similar spring in two pieces, the shaded part denoting one piece, and the dotted line denoting the other.

Fig. 12 is the same in section where the spring Φ presses against the other at *x*; the latter being secured at *z* prevents the pin *y* leaving the hole in the tang of the blade; therefore if you press the piece at & the pin at *y* is raised.

My invention is not confined to any particular kinds of razors, the improvements being applicable to all; neither is it confined to any particular number of notches on the back of the tang, but may be made with one, two, three, or more, as may be required, or fancy suggest; nor is it confined to the exact shape or form of the springs, as it must evidently appear to every intelligent workman that the same may be varied without departing either from the particular or general principle of any of the improvements above set forth and shewn in my invention.

In witness whereof, &c.

Description of an Improvement in the Striking Part of an Eight-Day Clock.

Invented by Mr. JOHN PRIOR, *of Nessfield, Yorkshire.*

With a Plate.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Bounty of Thirty Guineas was voted to Mr. PRIOR *for this Invention.*

I BEG leave to state some of the advantages arising from my improvement in the striking part of an eight-day clock. First, its principle consists in a wheel and fly,

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fly, with six turns of a spiral line cut upon the wheel, for the purpose of counting the hours. The pins below this spiral elevate the hammer, and those above are for the use of the detent.

This single wheel serves the purpose of count-wheel, pin-wheel, detent-wheel, and the fly-wheel, and has six revolutions in striking the twelve hours.

Suppose a train of wheels and pinions, used in other striking parts, to be made without error, and that the wheels and pinions would turn each other without shake or play. Allowing the above supposition to be true, which every mechanic knows it is not, my striking part will be found six times superior to others in striking the hours 1, 2, 5, 7, 10, 11, and twelve times in striking 4, 6, 8, and eighteen times in striking 3, 9, and 12.

I have designedly made a defect, in the model herewith sent *, in striking two and three o'clock, to shew that what I have now advanced will, upon the trial, be found to be true.

In striking two I have purposely made an imperfection, equal to the space of three teeth of the wheel; and in striking three an imperfection of nine or ten teeth, and yet both these hours are struck perfectly correct.

The flys in clocks turn round at a mean about sixty times for every knock of the hammer, but mine turns round only three times for the same purpose; and suppose the pivots were of equal diameters, the influence of oil on them would be as the number of revolutions in each †.

It would be better for clocks if they gave no warning at all, but the snail-piece to raise a weight somewhat

* Preserved in the Society's repository for public inspection.

† See Cummings's Elemen s.

similar

similar to the model now sent for the inspection of the Society.

REFERENCES to Plate X.

Fig. 1, A, the large wheel, on the face of which are sunk or cut the six turns of a spiral.

B, the single worm-screw, which acts on the above wheel, and moves the fly C.

D, the spiral work of the wheel A. The black spots shew the grooves into which the detents drop on striking the hour.

E, the groove into which the locking piece F drops when it strikes one, and from which place it proceeds to the outward parts of the spiral in the progressive hours, being thrown out by a lifting piece H, at each hour; the upper detent G being pumped off with the locking piece F from the pins in the wheel A.

In striking the hour of *twelve*, the locking piece, having arrived at the outer spiral at H, rises up an inclined plane, and drops by its own weight to the inner circle, in which the hour *one* is to be struck, and proceeds on in a progressive motion through the different hours till it comes again to *twelve*.

I, the hammer-work, made in the common way, which is worked by thirteen pins on the face of the spiral.

Fig. 2, K, the thirteen pins on the face of the spiral, which work the hammer-work.

L, the outer pins, which lock the detent.

M, the pump-spring to the detent.

On

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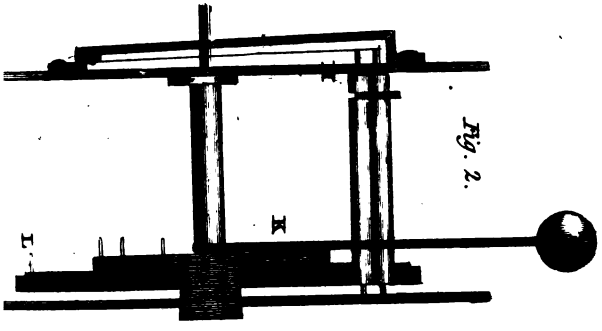

Fig. 2.

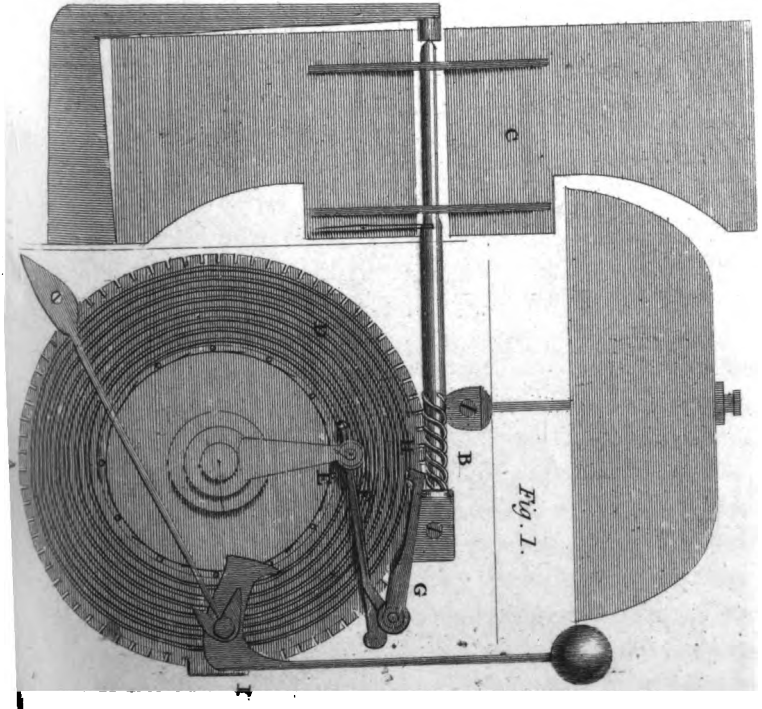

Fig. 1.

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Useful Hints for the Management of a Farm-Yard.

By CHARLES HOWARD, *Esq.*

From HUNTER'S GEORGICAL ESSAYS.

IT is not sufficient to attend to the general theory of agriculture, for however scientifically this may be studied, unless the minutiæ of the practice be indefatigably observed, the system of husbandry must remain incomplete. Of the less branches of this art, one of the most considerable, and of the greatest importance, is the good order and economy of the farm-yard. To raise the most valuable and largest quantity of manure should be the great object of every farmer; upon this circumstance the vigour and health of his land will principally depend. Every thing, therefore, that can contribute in the smallest degree to the size or quality of the dung-hill is of the utmost consequence.

For this purpose I should recommend farm-steads to be built with very requisite convenience, which, by attending to the real utility, rather than the appearance of the buildings, may be done at a moderate expense. The tenant can amply afford a proper rent for such conveniences, and it is very much to his interest, as well as to that of the landlord, to have them. Grazing farms, which do not produce great quantities of straw, require to be better accommodated with sheds and houses for cattle than large arable farms; as, upon the latter, economy of straw cannot be so closely attended to. The yard will be found more convenient if divided into two parts; as it is always desirable to separate the younger stock from those that are older; so circumstanced, they are more at rest, and consequently thrive better. One pump will water both yards, which is far preferable to the old mode of permitting the cattle to go to an adjoining

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ing pond to water, by which a great quantity of manure is lost, and much ground poached by their feet. The yard should form altogether a shallow basin, to preserve the liquid part of the manure; and it will be found very advantageous to lay at the bottom a considerable quantity of sand, or any absorbent upper soil. This should be done every spring and autumn, when the cattle are confined *all* the year; but if they are only taken up in the winter, once will be sufficient: each time the yard is cleared of the dung a very large portion of highly-valuable manure for grass land will be obtained from the bottom of the farm-yard, which may be again replenished with sand or earth. It is not within the limits of a short Essay, like the present, that all the advantages of this mode can be pointed out, the value of it can alone be ascertained by those who have practised it. The increased quantity of manure is very great, all the superfluous moisture is absorbed by it, and the farm-yard is kept in a much drier, and more comfortable state than it otherwise could be, particularly where attention is paid to the value of straw. But I admit that there are situations where, from the difficulty of procuring proper materials, this system can be only partially observed.

As soon as, from the severity of the weather, or bareness of the pastures, it is thought necessary to fodder the cattle, I should recommend them to be brought into the farm-yard, in preference to giving them hay or turnips whilst out. The cattle will be much better sheltered, and a larger quantity of manure will be made. Experience convinces me, that the dung of animals laid upon the ground at any season of the year, in its unfermented state, does not by any means enrich the land so much as when it has undergone a quick fermentation, with a small quantity of litter. Let as many cattle be tied up in houses

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houses or sheds as the buildings will admit of, particularly the fattening beasts. Cows and calves thrive better, and require less meat in the house, than when exposed to all changes of weather in the farm-yard; the waste is not near so great, and consequently the manure is improved by the straw being eaten, rather than trodden down into litter. I have before said, that the great object of the farmer should be to keep the largest possible stock of every kind of cattle, to augment and improve his dung-hill: I would therefore have every care taken to make the straw go as far as it can; and I speak of straw more particularly, as I do not consider hay, in general, a profitable crop for the farmer. When we observe the common method of using straw, it is not to be wondered at, that it should be under-valued; it is too frequently and injudiciously made the sole food of cattle, which (especially when coarse and ill-gotten) they shew by their daily decrease of condition; an obvious circumstance, that it does not afford them sufficient nutriment: such cattle, in the spring, are turned from the farm-yard to grass in so poor a state, that two or three months are often necessary to get them again into the same condition they were in when taken up in the autumn. This proves a severe check to the young cattle, which it very materially injures, and is a great drawback on the farmer's profit. But let straw be made subservient to turnips, carrots, cabbages, kale, potatoes, &c. Let a certain portion of these crops, according to the nature of the farm, be given to the cattle, and a very large quantity of winter stock will be kept in a progressive state of improvement; which upon all soils will prove exceedingly profitable. I believe it will ever be found for the interest of the farmer to keep all his stock in high condition, more particularly young animals, as they will come

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sooner to profit, and are at all times saleable; it is well known that animals, when fat, consume much less food than when in a lean state.

I have paid great attention to the nutritious qualities of the turnip, not only in the feeding of cattle, but of horses and store pigs; all of which I find to thrive exceedingly well upon them in their raw state. It has been my practice to give my draught-horses about a peck and a half of turnips each every night, with a fodder of straw; and I am of opinion, that they thrive as well, and keep in better health by this mode, than they would do upon the best hay. The turnips are given to them whole, but without the tops and fangs. On land where they draw clean, and in dry weather, they will not require washing; but if dirty, they must be washed; this, however, is seldom the case with me. In the day-time, whether worked or not, they have hay, and a small quantity of corn, with sometimes an addition of a few carrots in the stable; but on days of rest they are turned into the farm-yard for two or three hours, where they enjoy the turnips with the cattle. By these means my draught-horses are kept in good condition, at a comparative small expense, and a great consumption of corn is avoided; their bodies are temperate, and their legs are constantly clean. My cattle have turnips in proportion to their respective conditions and ages; but all have some, and are thereby kept in a state of improvement; my general plan is, to let them all out into the farm-yard about four hours during the finest part of the day, at which time they all eat turnips, having straw only in the house, excepting the cows, calves, and those cattle which are fattening. Even my pigs, which are of the Scotch and Leicester breeds, eat turnips in considerable quantities; I find them

answer

answer very well for store pigs, with the addition of the little other meat they pick up in the yard.

The value of turnips, as food for sheep, has long been fully allowed. For cattle too they are gaining ground considerably, but I think are generally given only to such as are fattening, and to cows and calves. Store cattle are much neglected in the winter season; I have met with very few farmers who have made turnips a common food for their draught and young horses; or who have considered them valuable as food for pigs; but from my own experience I venture strongly to recommend them for these purposes; at first, perhaps, they will object to them. In a few days they will eat them a little, and when some begin to feed upon them, all the rest will quickly follow the example.

The Ruta Baga I have heard recommended as far superior for these latter purposes; and am inclined to think, from the closeness of its texture, and its sweetness, that it is more nutritious; but I have not been successful in raising a good produce; it appears to me to be a very precarious crop. I propose, however, to give it a farther trial; and should be sorry to say any thing that might tend to discourage the cultivation of a plant possessed of so many valuable properties. Carrots, cabbages, and kale, I consider as highly necessary crops upon all farms; the two latter particularly so upon strong soils; they are an excellent resource in long frosts and deep snows, when turnips are with difficulty procured. It is desirable to grow them as near the homestead as possible. I find the method of preserving turnips from the frost, as mentioned by Mr. Marshall in his "Minutes of Agriculture," page 190, of great use, as a constant supply is thereby provided, notwithstanding the weather. Before the frost sets in, I employ boys to assist my own

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labourers in cutting off the tops and fangs; the tops are carted home for the immediate use of the cattle, or spread upon grass land for the sheep. The bulbs are thus preserved: a layer of straw is spread in a round form upon a dry part of the land, and the turnips are carted to it; four or five loads are heaped and covered with straw; a little earth is put at the top, in the manner of potatoes; only, as they seldom lay long, quite so much care is not necessary. Thus they remain until a frost causes a demand for them in the farm-yard, at which time they are particularly serviceable, if they are led home without injury to the land or roads. They might also be protected thus for sheep, which would greatly lessen the consumption of hay in severe weather.

Corn, in the straw, I have cut in small quantities, and think it is very useful to give to horses in the day-time when it is required to have them fed quickly, that they may get to work again; but I am of opinion where chaff is plentiful, much of this will not be required.

On the Treatment of Farm Horses.

By JOHN BANNISTER, *Esq.*

FROM HUNTER'S GEORGICAL ESSAYS.

ON the economy of the stable depends, in no small degree, the profit or loss of the husbandman; since, if the working cattle are disproportioned either in number or size to the exigencies of the farm, or if properly adapted in these particulars, should turn out unhealthy, either from natural causes or an undue attention in the persons to whom the management of them is entrusted; or if they are over-worked, or, on the contrary, not kept with a sufficient degree of strictness to their labour; if they

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they are pampered too high, or have not a due allowance of food: in either of these cases the owner will find an evident diminution in his profits; and, if not timely redressed, a want of attention to these minutiæ, as they may at first sight appear, will increase, by slow progressions, till the evil may at length terminate in the ruin of those people who have been remiss in this part of their business.

The number, as well as size, of the working horses must depend on the situation, extent, and nature of the farm; since one team on a gravel, sand, or other light soil, will cultivate a larger proportion of ground in a given time than two on a clay, where the native adhesion of the soil enhances the difficulty of the several operations of the field, and where the deep and miry roads render a larger strength of cattle abundantly necessary. Again, the farmer whose fields are hilly and uneven will be under the necessity of supplying himself with more able horses to answer this superior strength of tillage, than another whose lot has thrown him on a level situation. Such people also who have a large proportion of wood land, or who from any other cause are obliged frequently to perform long journeys, demand an abler team than he, whose chief employment is the tillage of his ground, and is therefore rarely under the necessity of travelling on the road, except in the necessary conveyance of his grain to market, the proximity or distance whereof is an object of no mean import to the farmer; since, if his situation be in the vicinity of a market-town, more corn may be delivered in one day than in two or three where the barns lie at the distance of eight or ten miles, or perhaps farther, as is the case with many farms; and if the various items saved by this contingency were to be added together at the year's end, they would,

I am

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I am persuaded, form a much larger sum than is generally imagined.

The proportion of meadow or feeding land to the arable is likewise to be considered in regulating the number of working cattle on the farm, since, when there is a due allowance of the former, there will be less employment for the horses; and consequently on these farms, where there is an equal division of arable and green land, one team will be amply sufficient, where there would otherwise have been a necessity to employ two or three.

The sex of the labouring cattle will likewise be determined by the nature of the farm, as it may be more convenient to employ geldings if there is a want of pasture, whilst a due portion of green land may encourage the farmer to drive chiefly mares, by which means he will have the advantage of breeding colts, and thereby of furnishing himself with a constant succession of young cattle at a trifling expense; and this is so material a consideration, that it ought never to be neglected where there is an opportunity of reducing it to practice; since, when a person is obliged to supply the deficiency of his team, whenever age or accident render it necessary for him to recruit his stock, by having recourse to the dealer, it forms a continual drain from his pocket, and lays him under the necessity of expending a considerable sum in the purchase of working cattle, which, when he has the advantage of breeding them on his own pastures, might be reserved towards the purpose of buying other stock, and his team would in all probability be more completely furnished with his own breed than by any which he could purchase from the horse-dealer, with whom he runs great hazard. Other advantages likewise attend the husbandman who is fortunate enough to possess a quantity of pasture land in due proportion to the arable, I mean

advantages

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advantages pertinent to the subject in hand, for as to the general superiority of farms of this description over mere arable tenures, it is so manifest, as to occur in a thousand instances; but in this particular one of the management of the teams, I would mention the being able to turn out a sick or lame horse, and thus in many cases expediting a cure in a much more effectual manner, and at far less expense than if recourse were had to the farrier. Besides, where mares are kept in preference to geldings, a disorder which would totally disqualify the latter for business will render the former by no means less proper for breeding, and thus she may still continue useful in this particular, whilst her offspring supply her place in the harness.

In those countries where the ploughed land is stiff and perfectly free from stones, and where the pasture is of the richest kind, the use of horses is in a great measure supplied by oxen, which, being turned out of the team into the feeding pasture, bring a double profit to the owner. The expense of maintaining these creatures in good working order bears no proportion to the consumption in hay and corn required for the horses, besides the very material saving in the article of shoes, wherein a horse-team considerably enhances the blacksmith's bill. These advantages speak greatly in favour of an ox team, where the situation will admit of the practice; but where the land is stoney and uneven, and the roads hard and rugged, and where the farmer is not possessed of sufficient quantity of good fertile meadow land to admit of the beast being fattened on the pastures, when he has been worked a sufficient time: when either of these circumstances are wanting, it is certainly the most judicious method to employ a horse-team; for the ox, at best a slow mover, would make

make but very indifferent way on ground that is hard and stoney, as in that case he must necessarily be shoed, and this is a task of no small difficulty, these animals being endued with far less docility than the horse, and are generally cast whenever this operation is performed. Besides, where the farmer has no convenience of fattening the oxen when past their labour, he must often sell them at a disadvantage to the feeding grazier, so that on these considerations the horse is by far the most useful beast; but in deep miry countries, as I observed before, the ox may be employed to great advantage.

The horse is subject to a greater variety of disorders than any other of the animal race, and these are often aggravated by ill management; nay, I believe I might add, that more distempers are brought on by a neglect or improper regard to the creature, than what proceed from natural causes.

As the complaints incident to this animal are more numerous, so is he more susceptible of injury from the different vicissitudes of heat and cold than any other creature. The ox, when he has finished his stated task for the day, is turned abroad to feed, without any other care from the hind; whilst the horse is taken into the stable at the close of his labour, and diligently attended during the remainder of the day, and at night left to repose on a dry and well-shaken bed. The horse meets with an early attention in the morning, and is alternately fed and curried before he goes forth to work, in order to enable him the better to withstand the fatigues and labour of the ensuing day; the ox, on the contrary, fearless of the summer's sun and winter's blasts, is taken out of the field, and with very little ceremony harnessed for his work.

Such being the care required in the management of a working-team, how necessary to the farmer's interest is it,

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it, to be provided with a set of domestics sober, honest, and diligent, who by obliging their horses to do a good day's work at whatever business they may be employed, and by a frugal, yet necessary allowance of meat in the stable, and by a proper attention to the dressing and well ordering of their cattle, will take care that their master's interest be promoted, and his welfare consulted in every particular. But however ardently the possession of servants with qualities like these is to be wished for, I believe there are few that have kept dependents of any kind who can boast of having often met with those which have turned out perfectly to their wishes; perhaps if we were to extend our inquiries in this particular from the prince on the throne to the villager, whose only attendant is a dirty girl; I say if we could search into the characters of these various degrees of servitors, we should find that all of them in their several stations, so far from studying the interest and profit of their master, directed their views towards enriching their own coffers, at the expense of their employer; and whilst the courtier has his parasites and dependents to share with him in the plunder of his Sovereign, the solitary domestic of the villager above-mentioned finds some char-woman or itenerant ballad-singer to receive the scraps of the pantry and the refuse of the kitchen.

In this progressive scale, there are none who study more arts of deception, and perhaps there are few of the several ranks and denominations of servants, from the palace to the cottage, who have fairer opportunities of exercising their dexterity in this way than those employed by the husbandman. Being brought up from their infancy in the lowest habitudes of trick and knavery, and observing in their parents, and in every one of their own

order, a kind of emulation at excelling in every mean art and chicanery, and consoling themselves with the satisfaction, that so long as they keep within the letter of the law, and are free from capital offences, they may with impunity continue in the practice of this lower rank of vices, it is matter of little surprise that they should imbibe their parent's notions: and thus the ploughboy is no sooner admitted into the stable, than he is initiated into the vices of that seminary, and shows himself an apt and ready scholar by pilfering his master's corn, which as it is given to his master's cattle, the waggoner (his worthy tutor) persuades him is a matter of trifling concern, and by no means a breach of the seventh commandment; till, by a frequent repetition of this crime, and from the force of example in his fellow-servants, he is led on to the commission of other acts, where this kind of casuistry does not so properly come in aid of his wounded conscienc.

Since these arts too frequently are practised in a farmer's stable, how careful ought he to be that his working cattle do not suffer either from the neglect of the ploughman, or from his over-solicitude to be possessed of a fat and sleek-looking team. Such horses may indeed attract the eyes of a gaping crowd at a country market, but will never answer the purpose of the farmer in getting through their daily labour with a moderate proportion of meat; and a due attention to these particulars would, I am persuaded, be the means of preventing many of the disorders to which this useful species of animals is naturally subject.

TO BE CONCLUDED IN OUR NEXT.

Letter

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Letter from Mr. BOSWELL *respecting the Ship Economy, a Vessel built according to the new Method invented by him, for which he lately obtained a Patent* *.

Communicated by the Author in a Letter to the Editors.

GENTLEMEN,

AS you had the goodness to insert in your Repertory of Arts † an account of the construction of the ship Economy, of London, built under my immediate direction, according to my patent, I hope the following relation of her performance at sea (which proves that she is equal to any other ship in every respect, and superior to many) will obtain also a place in your publication, and be acceptable to your readers, who know the importance of improvements of this nature in naval architecture, to a nation whose chief dependance is on her maritime strength, and where large ship-timber is every year becoming more scarce.

Extract of a Letter from Captain Alexander Smith, Commander of the Economy, to William Lushington, Esquire, Part-owner.

"Sir, Grenada, Oct. 15, 1804.

"I have the pleasure to inform you of the ship Economy's safe arrival here, with convoy, yesterday evening. We have had a very fine passage, and but one gale of wind. The ship performs as well as it is possible for a ship, is remarkably easy at sea, steers and sails well, and is perfectly tight. In the gale of wind the Epervier, M. W. sprung her foremast, the Robert Aylward, ditto,

* Vol. IV. page 430, of the new series.

† See the specification, published in the second volume, new series, page 81.

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a brig (master or brig named) Swinger, lost both topmasts, and parted convoy in lat. 14, 39 N. Our ship behaved extremely well, and never strained a rope-yarn.

(Signed) "ALEXANDER SMITH."

The unexagerated veracity of the above account may be implicitly relied on, in addition to which I have to state, that the Economy also sails remarkably fast; as a proof of which, having been detained in the Thames for part of her outfit twenty-four hours after the convoy had sailed (when she was outward bound to the West-Indies in August last, 1804) she afterwards passed by most of the fleet between the Thames and Portsmouth, and was one of the first vessels which arrived in Portsmouth harbour.

Having found that the room taken up by the transverse frames in the Economy was objected to; I take this opportunity to assure your readers, that I am acquainted with very sufficient means, within the limits of the patent, for reducing this inconvenience to so small a degree, as to render it an object of no material consequence in any other ship built in the same manner: and, besides this, at all events, if a vessel built on this plan will cost much less than one of the usual construction, stowing precisely the same quantity, it is evident this can be no material objection. I can moreover prove to any unprejudiced person, that there is more space gained internally, from the smallness of the vertical timbers in the intervals between the fore and aft ribs, (and from the absence of knees) than can possibly be occupied by the constituent parts of the transverse frames.

I am, Gentlemen,

Your very humble servant,

JOHN WHITLEY BOSWELL.

Experiments

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Experiments and Observations on the Feathers and Down of Domestic Fowls. By M. PARMENTIER.

From the ANNALES DE CHIMIE.

IT is not merely for their flesh, their fat, and their eggs, but also for their feathers, that fowls are pursued in the field and reared in farm-yards; but these feathers, which nature has given them for their clothing, and also to form the principal instrument of their flight, have different destinations of more or less utility to society.

Some remarkable for their softness and elasticity, for the beauty of the filaments which compose their plumage, serve to shade the helmet of the warrior, to adorn the tresses of the fair, and to form those elegant plumes with which the most splendid articles of furniture are surmounted.

Others, valued on account of the length and the solidity of their quills, and the facility of cutting them into any desired shape for writing, become the interpreters of our thoughts; they advantageously supply, among the Europeans, the place of the reed, which the Arabs employ, and the style with which the ancients engraved their tablets.

Finally, there are feathers adapted for filling those cushions upon which, fatigued with the labours of the day, we repose during the night; it is among these that Voluptuousness herself has selected a species of peculiar fineness, lightness, and elasticity, to form the bed upon which she tastes the sweets of repose.

Plumes and other Ornaments of Luxury.

The most beautiful and the most valued of all plumes are those made of the feathers of the ostrich; this singular biped, which has the feet and parts of generation of a quadruped,

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quadruped, the head of a bird, and also the faculty of laying eggs; the stomach and intestines of the ruminant animals, and yet the gizzard of a fowl; which has its body covered partly with feathers, and partly with hair, and, finally, wings, which do not serve it as instruments for flying, but only for balancers, with which it supports itself, and easily preserves its equilibrium in the extremely rapid courses which it performs in the deserts of Africa.

The plumage of the male is black, with some grey and white feathers; that of the female is brown, or of an ash-grey. The large feathers of the wings and of the tail are white with the males, and black with the females.

What particularly distinguishes these large feathers, and renders them admirably adapted for forming plumes, is that they are soft, open, flexible, that their plumage, composed of detached filaments, without consistence and without cohesion, is long and well filled; and, finally, that the white feathers of the male are capable of taking the most beautiful tinges.

The rarity and dearness of these ostrich feathers, which are brought to us by the Levant trade, would undoubtedly have caused it to be attempted to naturalize this gigantic bird in Europe, if it had been thought capable of thriving any where but in the burning sands of Arabia. But there is another species of ostrich, that of Magellan, which, being a native of the cold countries of South America, might prosper in our climates. It ought to be attempted to bring it hither, and cause it to propagate, in order that we might avail ourselves of its eggs, its flesh, and its feathers.

Whilst awaiting the success that may be hoped from this speculation, there is another which would succeed more speedily and certainly, namely, to multiply the breed of turkeys with white feathers, and to employ for plumes

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plumes the feathers which are situated at the sides of the upper part of the legs of these fowls. This supplement to the ostrich feathers would become useful in commerce. We invite the breeders, who occupy themselves with the rearing of this bird, to attend to the profit which such a branch of industry might produce.

Besides the large ostrich feathers which we see wave with such grace over the heads of our ladies, there are others, taken from other birds, which also serve as ornaments in their dress, such as the feathers of the Bird of Paradise, and especially those long and beautiful black feathers which come from the top of the head of the heron, forming an aigrette which rests upon their neck.

Luxury has also applied the feathers of the peacock to the purposes of ornament; the gold and jewels which nature has lavished upon the tail of this superb bird belong to her province; those of the gold-birds, the humming-birds, and others of the large family of peckers, have presented to her the freshness and velvet-softness of flowers, the polish of the most brilliant metals, the lustre of the most precious stones, and the varied and dazzling reflections of the rays of the sun. She has employed in the embellishment of dress the beautiful and brilliant yellow feathers of the throat of the toucan. Nor has she even disdained for this use the azure feathers of the jays, with which he in the fable would not be contented.

Some time ago, such an active warfare was carried on against the birds, in order to procure these feathers, that the husbandmen flattered themselves that they should soon be ridded of them. But unfortunately the feathers of the jay have come out of fashion, and this bird continues to pillage the fields as before.

But it is not only for objects of shew that luxury has employed feathers adorned with the most brilliant colours;

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lours; it has also been contrived to render them of some utility.

With the skins, provided with the feathers, of the same birds, to which those of the swan, the duck, the diver, the pheasant, &c. have been added, muffs and tippets, have been made.

What a variety in the natural or artificial colours of these winter ornaments! what softness! what smoothness! what whiteness, in that down of the swan with which the women guard their throats and necks against the cold, and of which their powder-puffs are made.

The skins destined for this purpose, says M. Vieillot, in the new Dictionary of Natural History, ought not to be those of birds which have died of disease, or have been killed in the time of moulting; the feathers would detach themselves, or would not yet have attained to their perfection. We ought therefore to employ only those of birds killed in a healthy state, and skinned a short time after their death, especially in hot weather, otherwise the same effects would be produced by corruption as by disease.

As soon as the skin is cleaned from all the flesh, it is spread out upon a small table, with the plumage downwards, and the feathers well arranged above each other. In order to extend it the better, it is fixed with pins or thread on each side; the fat and flesh which may still remain attached to it are then removed, and if there be any rents in it they are stitched up with silk. The skin is then spread with a paste, prepared with a handful of flour, a little fine common salt, and as much good white wine as is requisite to bring it to a proper consistence.

The skin being thus prepared, it is put to dry in the shade, exposed to the north wind, and when it is dry it is cleaned by scraping, which is easily done, as the paste separates

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separates in scales: if after this operation it still retains any moisture, it is again spread with the paste, and put to dry a second time.

When it is quite dry it is fastened with thread upon paper or a ribbon, and, in order to preserve it, it is put into a box, the bottom of which is covered with worm-wood or rose-wood. If we wish to give the skins an agreeable smell, we must, before taking them from the board, and after having scraped them, apply to them with a sponge a layer or two of some odoriferous composition.

When the skins are those of large birds, instead of wine, vinegar is used, having salt and alum dissolved in it; of this mixture several layers are given them, the quantity being regulated according to the thickness of the skin.

Writing-Quills.

The quills, for this is the term applied to the feathers of the wings and tails of birds, to distinguish them from the feathers properly so called which cover their bodies; are the longest and strongest of all the feathers. Those of swans, of geese, and of ravens, are employed in preference to all others for domestic purposes; and this according to the qualities which have been discovered in the barrels of each.

Thus the swans' quills are the most esteemed for writing and forming pencils; thus goose-quills, which are more plentiful and almost as good as those of the swan, are more generally employed for writing; thus the quills of the raven are employed more particularly by the harpsichord-makers for quilling the jacks, and by limners for penning drawings.

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Manner of clarifying the Quills.

The bird which affords the greatest quantity of writing-quills is the goose; a single one may yield them of ten different qualities; but there always remains upon their surface a fatty matter, from which they must be freed, in order to render them pure, transparent, shining, and clean; in a word, to give them the qualities which they ought to possess. This preparation is principally performed by the Dutch. Hence the expression in French, *hollander les plumes*, to denote the operation which the quills are made to undergo. I availed myself of the circumstance of the war, when several apothecaries, instructed in the arts and sciences, were employed in Holland, to solicit them to collect some information respecting this process, hitherto unknown. The following is what they have communicated to me. I wish that by repeating them a satisfactory result may be obtained.

The process consists in plunging the quill, as drawn from the wing of the fowl, into water nearly boiling, letting it soften there sufficiently, compressing it, turning it on its axis with the back of the blade of a knife. This kind of friction, as well as the immersions in the water, having been repeated till the cylinder of the quill is perfectly transparent, and the membrane as well as the kind of greasy matter which cover it entirely removed; it is immersed for the last time, in order to render it perfectly cylindrical, which is effected by means of the fore-finger and thumb. It is then put to dry in a moderate temperature.

Feathers and Down for Cushions.

Bolsters, pillows, beds, and cushions, may be filled with the small feathers of the gallinaceous tribe of fowls and pigeons. There are even some provinces in

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in which they are already employed for this purpose, but most generally the down of the web-footed fowls is chosen in preference. We should also gladly employ that of the birds of prey, if they were sufficiently numerous to afford an adequate supply of their thick soft plumage.

There are two species of down; the one, which is neglected, consists of light, soft, detached feathers, without cohesion, and curly, which covers many young birds as soon as they are hatched, and falls off as they increase in size; the other, which has more adhesion, and which is collected with great care, is that with short barrels and long, even disunited feathers, which Nature has given as a warm clothing to the birds which fly high in the air and to those which are aquatic, in order to protect them against the cold which they would experience without its aid, the one in the higher regions of the atmosphere, and the others in the contact of the water. This down, with the last, is also covered externally with a close and oily plumage, which entirely preserves them from moisture, and thus enables these birds to preserve their natural heat.

The down of the birds of prey, which is known by the name of *Eiderdown*, being, as we have observed, very rare, means are scarcely thought of for obtaining any other than that of the web-footed fowls, a very numerous class of birds, of which three principal species have been domesticated, namely, the swan, the goose, and the duck.

But before we speak of the manner of collecting the down of these three birds, we must say a few words concerning a down which is much superior to them, for its softness, lightness, and elasticity. This is the Eiderdown, furnished by a species of duck which is a native

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of Iceland, called the Eider-duck, *Anas mollissima*, Linn. The following account of it I take from Sonnini, the deserving friend of Buffon, and one of the principal authors of the new Dictionary of Natural History.

The Eider-ducks pluck the down from their breasts and bellies to line their nests, and to warm their eggs and their young ones; it is sought for with much assiduity in all the countries where these birds are common; it is the softest, the lightest, the warmest, and the most elastic of all downs. Norway and Iceland yield this valuable substance, which sells there as high as a pistole the pound, when it is well picked and pure.

The nests of the Eider-ducks, in the north of Europe, are to the inhabitants of those coasts a kind of property, the ground of which, though free, is not less constant and sure. Every one enjoys in peace the nests placed upon his ground, and does every thing in his power to attract the couples of eiders thither. A severe fine is inflicted upon whoever kills any of these birds. A single person, especially if his habitation is placed on one of the rocks the most remote from the land, may collect in one year from fifty to a hundred pounds of down. The Danes purchase all that they collect. But it is an universal rule, that the down taken from a dead eider is of an inferior quality to that which it plucks out itself. We have already made this observation, and we add that it is general with respect to all birds.

There is, in fact, an enormous difference between the feathers plucked out of the living animal and those which are taken from it when it has died in consequence of a disease; the latter have very little elasticity, their plumes are caked together by the least moisture; they have also another inconvenience, namely, that, though passed through the stove, the mites attack them much sooner,

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sooner, and reduce them to powder in a very short time.

But not only the feathers of domestic birds present this difference, wool and hair are equally subject to it: the wool, shorn from an animal dead of disease, is not by far so much esteemed as that which is taken from a healthy sheep; even the state of the disease considerably depreciates its quality. All the textures made of the hair of an animal that has died of disease have no strength; the dealers therefore are very careful to tell us that their hair comes from a living animal; perhaps the experience of practice teaches them to distinguish it in other ways than by the wear.

The case is the same even with respect to the ivory which is collected accidentally in the countries inhabited by elephants, and that which is taken from an elephant that has just been killed; the latter, which is very easily distinguishable by every turner, is of much greater value, of a finer white, much less brittle, of a better grain, and capable of a more beautiful polish.

Swan's Down or Feathers.

Among the wild swans there are some whose plumage is entirely white, like that of the domestic swans; others, and these are the most numerous, are more grey than white, and this grey when darker appears almost brown upon the head and back.

The domestic swans are plucked, like the geese, twice a year; they afford a down which is esteemed for its softness, and used for filling cushions and beds. It is known that the same substance, which is extremely fine and softer than silk, forms also powder-puffs; likewise beautiful muffs and fur linings, equally elegant and warm, are made of it. The feathers of the wings are preferable

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to those of the goose, for writing and forming the tubes of pencils.

Duck's Down or Feathers.

Though in some provinces the feathers and down of the gallinaceous fowls and pigeons is not neglected, the web-footted tribe furnish the largest quantity of what is consumed in Europe.

The down of ducks is sufficiently elastic, and is sold at a certain price in Normandy, where large quantities of these fowls are reared. It is made into pillows, beds, &c.

Down or Feathers of Geese.

The common goose, and especially the large kind, which has been domesticated from time immemorial, furnishes the greater part of the feathers and down employed in Europe. The opinion has long been entertained, that it was directly prejudicial to the health of these birds to pluck them; however, the operation being performed before the moulting, this periodical malady, common to the rest of birds, is not followed by any inconveniences, when it is performed at the right time, with skill, and in such a manner as to take away from each wing only four or five feathers and the down.

As soon as the goslings have attained the age of two years, they are conducted several times into clear water; they are then exposed upon a bed of clean straw, in order to dry them, and they are expeditiously plucked for the first time, and a second time at the commencement of the autumn, but with moderation, on account of the approach of the cold weather, which might incommode them.

Another precaution, which ought always to be observed, is that, when the geese have been recently plucked, they must be prevented from going to the water,

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water, and confined to drinking for a day or two, till their skin has become hardened; finally, they are plucked a third time, when, after having been fattened, they are killed. Thus this bird, which has lived about nine months, may furnish during its life three crops of feathers.

The profit which may be derived from the feathers of geese is by no means to be contemned; they form an important article of commerce in the county of Lincoln, in England, both in down and writing-quills.

It would therefore be throwing away very unnecessarily a certain and considerable profit which may be obtained from a numerous flock of geese, to neglect gathering once, twice, or thrice a year, a crop of quills for writing, and of down for pillows and beds. It has been estimated that this product varies according to the age of the fowl, and that an old goose commonly yields her pound of feathers, whilst a young one pretty constantly affords half a pound.

The geese destined for the farm-yard, and which are what are termed the old geese, may, it is true, be plucked without inconvenience three times a year, at intervals of seven weeks; but the goslings must be suffered to attain the age of thirteen or fourteen weeks before this operation is performed upon them, especially those which are intended to be eaten early, as they would grow lean, and be deteriorated in quality.

The nature of the nourishment contributes very essentially to the value of the down and the strength of the feathers; the particular care which is bestowed upon the geese has no less influence upon them. It has been observed, that in places where these fowls find plenty of water they are not so subject to vermin, and that they afford feathers of a better quality.

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There is a kind of maturity with respect to the down, which is easy to be distinguished ; it is when it begins to fall spontaneously ; if it be plucked too soon it does not keep, and the worms get into it. Lean geese furnish more of it, and that of better quality, than the fat ones. The farmers ought never to suffer the feathers of the geese to be plucked some time after they are dead in order to sell them ; they generally have a musty smell, and cake together. None ought to be introduced into commerce except such feathers as have been plucked from live geese, or those that have just been killed ; in the latter case they ought to be plucked without delay, and, if the operation can be completed before the fowl has become quite cold, the feathers will be infinitely the better for it. It is also the custom to turn their feet behind their backs, so as to support their wings, without which they would break, and the geese would be no longer saleable.

Drying of the Feathers.

Whatever may be the species of birds that furnish feathers in the greatest abundance, those which are the most esteemed ought to be plucked from the living animal, and it is easy to distinguish them by the circumstance, that their tubes, when pressed between the fingers, give out a bloody juice. Those which have been plucked after death are dry, light, and subject to be attacked by the worms and mites ; but the feathers and down of the best quality, gathered before the moulting, and at the proper season, require, as we have already observed, precautions, in order to preserve them in a good condition. They always carry with them a fatty and watery matter, which, by the changes which it must undergo, would

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communicate to them an extremely disagreeable smell. They must therefore be previously dried, put into an oven after the bread has been taken out; and it will be proper even to carry this desiccation to a greater length with the plumes of aquatic birds, on account of their very oily nature.

When this preliminary desiccation has been performed, the feathers are conveyed into a dry and ventilated place; they are turned every day, and by this means the marrow contained within their barrells is dried; the fatty and membranous parts of their surface are dissipated in the form of powder; and then the feathers may be kept for ages; but if these precautions are neglected, if the feathers are not reduced to the state of pure dry substance; if they contain juices half dried, they will then become a prey to insects; in this case they must be cleansed in soap-water, and afterwards washed in several waters, an operation which impairs the elastic quality of the feathers and occasions loss.

What we have said of feathers is applicable also to wool: if it has been badly purified, the fatty matters with which it is impregnated attract the insects, and it must then be washed in order to prevent the destruction of the whole, and to deprive it of that natural grease which corrupts it.

On account of the uncertainty in which we are with respect to the choice of the original substances that have been employed in the beds of a country house, we ought to place them upon a frame supported by poles in the middle of a large place well ventilated, to turn and beat them from time to time, to expose them frequently to the open air, in the cold of fine winter days, and in the sun at the commencement of spring, in order to keep

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them free from that species of insect, of the class of the phalenæ, which is propagated only in darkness and repose. The open air and agitation are means infinitely preferable to those aromatic plants which have been proposed with the view to produce this effect.

The purifying process consists in putting into three pints of boiling water a pound and a half of alum, and as much cream of tartar, diluted with twenty-three pints more of cold water; in which the wool is let soak for some days, after which it is washed and dried; it is then no longer subject to insects.

The purity of the feathers and wool, which are used for making mattrasses and cushions, ought undoubtedly to be considered as an object of the utmost importance to health. The animal effluvia may, in a number of circumstances, prove prejudicial to health; but the danger is still much greater when the wool is impregnated with the sweat and excrementitious matters of persons labouring under putrid and contagious diseases. Too much care can therefore not be bestowed upon beating, carding, cleaning the wool, and washing the cloth of mattrasses. This is a precaution which ought to be taken every year by the careful housewife; and we earnestly recommend it to her, for the sake of the preservation of her family, and the interest of the domestic concerns, the conduct of which falls to her province.

Pyrotechnic

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Pyrotechnic Observations, and their Application to Evaporatory Furnaces. By M. CURAUDAU.

With an Engraving.

From the ANNALES DE CHIMIE.

SINCE I published my observations on the causes of the imperfection of the evaporatory furnaces, I have had occasion to make new ones upon the same subject, the application of which must tend to increase the advantages of the construction which I have pointed out.

In my first memoir * I shewed that the bottom of the boiler in the evaporatory furnaces not only opposed the elevation of the temperature, but that it also diminished the activity of the fire, which rather promoted the gazification of the combustible body than its oxygenation. I mentioned the Argand's lamps, and their glass tubes, to prove the necessity of elevating the temperature about the combustible substance, whenever we wish to have a complete and energetic combustion. At present it will be the enameller's lamp that shall serve me as the example upon which I shall rest my new observation; and I confess that it is to the examination of the effects which it produces that I owe those which it has given me occasion to make. In fact, if we examine the jet of flame of the enameller's lamp, we shall see that the intensity of its action depends upon the current of air which is directed upon the flame of the wick; we shall likewise see that it is only at the extremity of its jet that the greatest energy of the calorific rays resides, the intensity of which is such, that by means of this lamp we may obtain effects comparatively as powerful as those which would be obtained in our best furnaces.

* Inserted in the fourth volume of the present series of this work, page 383.

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This mode of action of the caloric proves that we may augment its effects by augmenting the rapidity of its current, and directing it properly towards the bodies to be heated. Such are the conditions which I have endeavoured to unite in my new construction, and which, after the application I have made of them, will serve to support an opinion which required the test of experiment upon a large scale, in order not to be classed among mere hypotheses.

Latterly, having been consulted upon the construction of a maltster's furnace, I availed myself of this circumstance in order to demonstrate the great advantages of the changes which my observations had appeared to me to render necessary in it, and to engage the proprietor to construct his furnace according to the plan which I sent him.

The following is the result of experiments made in order to ascertain the advantages which the new-constructed furnace has over that in the place of which it has been substituted.

The old furnace, to raise 2,500 litres of water to 50 degrees of Reaumur's thermometer, required two hours and a quarter, and it consumed, in an operation which is repeated every day, 625 kilogrammes of new dry wood.

The present furnace, on the contrary, consumes in the same operation only 450 kilogrammes of wood, and takes only an hour to raise 2,500 litres of water to 50 degrees of temperature; whence it results, that this new construction evidently produces a saving of time of $\frac{7}{24}$, and of fuel to the amount of nearly a third.

Such advantages have appeared to me sufficiently important to merit being generally known, and to render it desirable

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desirable that a new method, which may have the greatest influence upon the saving of the fuel necessary for the manufactures, may be carried into practice.

Description of the Furnace.

(See Plate VIII.)

A, Fig. 5, door of the fire-place; it is 40 centimeters broad and 35 high.

B. This part of the furnace represents a vault; it is 55 centimeters in height, 80 in breadth, and one metre 50 centimeters in depth. To add to the effect which the heat ought to produce, I give to the middle of the fire-place a depth of 50 millimeters more than to the extremities, which renders this part sensibly concave.

C, an aperture made in the middle of the vault, and destined to augment the velocity and the action of the calorific rays; it has 15 centimeters in height, which is equal to the thickness of the vault. This aperture, at its lower part, is 60 centimeters long and 45 broad: at its upper part it is 50 centimeters long and 35 broad, which gives to each extremity of the aperture the form of a spheroid, the largest axis of which is in the direction of the length of the vault.

D. The distance from the boiler to the mouth of heat is 15 centimeters at the middle, and reduces itself to 10 at the angle E, which produces the advantage of confining the incandescent rays in proportion as they lose their intensity by expansion.

From the angle E to F the distance is 2 decimeters; the intrant angle F is 6 centimeters distant from the boiler, and the saliant one only 3.

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G and H are angles similar to those of F, but only 3 decimeters distant from each other: these angles may be multiplied according to the height of the boiler. The advantage which they produce is to cause the calorific rays to undergo several refractions, which augments their energy at the place of their deviation.

I, is an aperture communicating with the chimney; it is 7 decimeters wide and 15 centimeters high. At the angle H, the half of the circumference of the furnace ought to be closed by a range of bricks, in order to compel the heat to direct itself from the opposite side of the chimney; immediately above this range of bricks, those which follow ought to be 10 centimeters distant from the boiler, and to be continued thus to the height of 10 centimeters: then each range of bricks are brought nearer together, in such a manner that this conduit of heat is closed at the height of 15 centimeters, which is then done over the whole circumference of the boiler.

K, is the orifice of the chimney; it ought to have, in its whole height, three square decimeters, and at least four meters in height.

L, represents a slider of wrought-iron; it is a meter above the boiler; it serves to open or close the chimney at pleasure.

The proportions laid down in this plan suppose a boiler one meter thirty centimeters wide at the lower part, and a meter in height.

Inquiries

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Inquiries respecting the tinning of Copper, Pewter, and Pottery. By M. PROUST.

(Continued from Page 140.)

THE more complicated the processes employed in the arts are, and the dearer the agents to which they are to be subjected, the more means they present to the dishonest workman for raising the price of the articles which he manufactures. The tinning, which costs at present about four reals, would cost at least ten, if that which has been thought capable of being substituted in its place had been practicable, since the latter is the product of three operations, namely, the first and the second bath, and the hammering in order to smooth it, and of the employment of two substances, the sal-ammoniac and charcoal in larger quantity, and also of much more time.

The proportions of one part and a half of zinc to one of tin, indicated by M. Buschaendorf, already gave reason for very well-grounded doubts on the first part of such a tinning. However little the other parts of the prescription, when subjected to an examination founded upon a knowledge of the arts, might have given rise to the same doubts, it would have been perceived, that the experiments of the author, though perhaps successful upon the small articles executed by able hands, were nevertheless not described in such a manner that one could be assured of success in operating upon a large scale. It would, in my opinion, have been proper first to confirm the experiments by application to the utensils of a hospital, or other large establishment, at Leipzic, and to ascertain the advantages of this tinning by authentic testimonies, before announcing it to all Europe.

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I caused to be tinned before my own eyes, and in presence of a pretty considerable number of witnesses, pieces of different sizes, first with fine tin, and afterwards with the alloy proposed; but whatever might be the ability of the workmen who laboured in these operations, none of them were able to apply the second bath in a satisfactory manner. The larger the diameter of the pieces was, the less successful were the results. Two workmen succeeded each in tinning a pan of eight or nine inches diameter; but the same workmen had no success with those of fifteen or sixteen inches diameter, with pieces of copper of a foot and a half in width, in their lids, in small alembics, in tea and chocolate pots. None of them chose to undertake the tinning of a copper cullender, only eight or nine inches in diameter.

A foreigner, who gave out that he was capable of solving the most difficult problems in his art, was not more successful than those who had preceded him, and he could not find either in his boasting, or in the privileged instruments with which he was provided for this purpose, the means of tinning a common chocolate-pot.

There are in all countries artisans who have no settled place of abode, who regard neither honesty nor the laws of the state, and who are always ready to derive from their craft the means of sacrificing the interests of a whole nation to the most paltry present emolument.

Of such, several presented themselves during the different experiments which were made for the purpose in question, whose services were offered rather with a view to elude than to resolve the problem, in order that thus the wise intentions of government might be confounded with their perfidious projects. But the authority which presided, in concurrence with science, over experiments upon

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upon which the public safety depended, disconcerted, with marks of indignation, such odious machinations.

To throw a quantity of the alloy prescribed into a bath of tin, in order to immerse it in it without dissolving it, and to incorporate it with that tin, as a quantity of sand may be thrown into melted fat, was to resolve the problem only for the purpose of over-reaching the probity of the judges.

In an utensil of copper, the effects of which are dreaded, it is necessary that a barrier should be placed between the metal and the aliments which are prepared in it, and this barrier is the tin. But if it be possible to reinforce it still by a second metal which shall augment the interval which must always be interposed between the copper and the aliments, it is certain that we shall then be able to remove all dangers, and dissipate all apprehensions. The intention of M. Buschaendorf was to cover the first tinning with a second of a more insoluble and more durable kind; but this author was very far from approving of the difficulties of his prescription being eluded by insiduous manœuvres which should frustrate our hopes, and which, without adding any thing to the present method of tinning, should serve only to disguise the truth in the eyes of persons who are not acquainted with the arts.

If the processes of the author have not proved successful among us, he has not the less claim to the esteem and gratitude of the public. We ought never to discourage those who labour to render themselves useful, but rather to aid them in surmounting the obstacles which oppose themselves to their zeal. Let us then rather endeavour, by expressing our sentiments of gratitude, to induce this author to seek out some alloy more proper for tinning, and better adapted for answering the wishes of society.

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It is well known that the tinning which has succeeded well in small articles with the aid of an excess of tin, which remained in the pan after the first bath, does not present in its second layer an uniform solution of the zinc in the tin. It is true, that a very small portion of zinc was dissolved in the tin; but the surplus was only a mechanical incorporation of some grains which might be reckoned by the mere aspect, and which were distinguished by the touch, by the asperities with which the pan was covered; which cannot be better compared than to a portion of sand incorporated with fat, with which one should offer to varnish a table, under the pretence that the sand is intended to harden the fat, and render the varnish solid. Such were the ideas to which this tinning gave rise among the disinterested persons, to whose examination it was subjected.

These same insulated grains of zinc have obliged the author to recommend flattening them down with the hammer, and as they subsist here equally, even after the application of the remedy indicated, they have not permitted this troublesome addition of labour to be dispensed with.

The zinc, in the application of its alloy, not only experiences a kind of separation which appears to be the result of a crystallization in the midst of the tin, which is more fusible, but it also is burnt or oxydated rapidly as soon as we endeavour to extend it over large surfaces, being transformed into a black scoria of the same nature as that which remained, as I have remarked, in the iron spoon, after the trials made for obtaining vessels of this alloy. This scoria, which cannot be reduced by resin, and which resembles that which Hellot and Geoffroy saw, destroys the tinning in such a manner, that nothing remains to be done than to have the piece scraped afresh, and new tinned.

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If artisans experienced in their art have not been able to get the better of these difficulties; if they have themselves declared that the success of one small article to ten which were spoilt was not to be attributed to their skill, but to certain circumstances which they could not command or determine, how should these men be able to adopt processes which would continually expose them to the necessity of recommencing, at their own expence, the tinning of the articles which were intrusted to them? Let us therefore leave far from the workshops science and its theories; and let the operations which they teach or improve be always of easy execution, as being to be practised by persons whose destiny it is, not to meditate upon them, but only to derive from them their means of subsistence.

On glazed Pottery.

When a clay is pure, white, and without any considerable mixture of oxyde of iron and sand, it may be fit for the fabrication of vessels of such a degree of hardness as to strike fire with the steel, after being baked; but clays of so excellent a quality are but rare. The Dutch possess such clays, and they make of them those oblong, round, and square flasks, in which they send us beer and other commodities. The quality of this clay is such, that the vessels made of them preserve the liquors as well as crystal bottles; and these vessels are besides improved by means of a glazing, of which I shall shortly speak.

The English likewise possess clays of the same quality. We also meet with at Madrid, though rarely at present, plates and cups of a potter's-ware of this kind, which strikes fire with the steel. They are glazed with the vapour of sea-salt, which is thrown into the oven when the pottery is baked. These vessels, which are so valuable

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in chemical laboratories on account of the resistance which they oppose to the acids, are however very heavy; their baking requires a great quantity of fuel, and their fabrication, on this account, becomes daily more rare.

In France they have also a clay which possesses something of this quality, or which at least they apply to the same purposes: I mean that of Savigny, in the province of Picardy, where it is termed *grès*, a word undoubtedly derived from *greda*, which is employed like many others which belong to the Spanish language *.

This pottery, without being as white or as fine as that of the Dutch and the old English pottery, answers nevertheless the same purpose to a great part of France. It is as hard as a pebble; it has scarcely any pores in select pieces; wine, vinegar, and oil, keep in it perfectly well; but the great consumption of fuel which it occasions renders the baking of it very expensive.

These three sorts of pottery would not be sufficient for our different domestic purposes, since they are too dense, of too solid a paste, and very liable to crack in the fire; they cannot therefore be employed for making boiling-pots, saucepans, &c.

The sandy clays, and even the calcareous ones, or, in other words, the marles, merit the preference for this purpose. Baked by fire, they become porous, in such a manner that they can, without breaking, endure the alternate action of fire and of water; however, they always crack more or less by use.

* M. Proust surely does not mean to say that there is no clay in France besides that of Savigny which can be baked into *grès* (stone-ware). Macquer mentions many others; we know at present some very white ones which have this property, and we must rank in this class all those which are employed in the different departments in the fabrication of glass-maker's crucibles. Note of the French editor.

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But if this pottery has the advantage of being able to bear the fire, it has, on the other hand, the demerit of suffering the liquids to transude by reason of its porosity. This defect it has been necessary to remedy by layers of glazings of different kinds.

There are, however, some kinds of pottery, the paste of which retains a sufficient degree of adhesion in all its parts, not to require this additional varnish, which is extremely useful to the countries where they are fabricated. Such are the pots of Zamora. I have already spoken of a glazing which is formed of the substance of the pottery itself, by means of salt, which, when thrown into the oven, is reduced into vapours.

Another glazing is also obtained from the surface of the article, by covering it for this purpose with lead previously oxydated, or with sulphuret of lead, which comes to the same thing, since the heat of the oven dissipates the sulphur, and promotes the oxydation of the lead which remains upon the surface. This oxyde dissolves the sandy particles which it meets with, and uniting with them it assumes the transparency of glass, which it could not receive by itself, and thus the vessel is glazed.

Among all the known productions with which commerce furnishes the arts, there is none which can afford this varnish at so advantageous a rate as the oxyde of lead. The use of the salts would be too expensive to afford pottery which should be within the reach of the indigent class of society.

If we wish to give to the pottery a more brilliant glazing, and which shall conceal the porosities, and the disagreeable colours which it acquires in the first baking, we must compose a glazing for the express purpose, the basis of which is always the oxyde of lead, to which a little sand is added, in order to give it the vitreous quality

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lity which it must no longer derive from the surface of the vessels, and mix with these two ingredients oxyde of tin, which has the property of giving a milky whiteness to the glass of oxyde of lead and sand. This glazing, when well vitrified, and adhering well to the biscuit, transforms it into what is termed *Talavera* *. This is a branch of industry which has fallen into decay in the hands of a nation which formerly surpassed all others, both in this and in many other branches.

But what is the Talavera of the present day compared with some specimens which we still meet with in different places, some remains, such as flower-pots, which have supported, for more than a century, cold and heat, frost and moisture, without a single crack being yet discernable in them? Who will now exhibit upon his table a piece of the Talavera which is manufactured at the present day?

When the clay is of good quality, and preserves its whiteness after the baking, it is kneaded with a portion of calcined and ground silex, for the double purpose of rendering it porous and making it present to the varnish which it is to receive, the sandy points of support, which must produce its adhesion with the clay, and which this earth would not have if it were pure.

The glazing is then composed simply of sand and oxyde of lead. This mixture is previously fused, in order that the ingredients may be reciprocally saturated and incorporated, in such a manner that neither of them may any longer be able to obey the attraction which before might attack and dissolve them. It is afterwards applied, baked, and vitrified, upon the surface of the ves-

* A town in Spain, where this kind of pottery is manufactured, and which has given it its name.

sel,

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sel, with such solidity, that no acid can separate from this glazing the oxyde which it contains.

And what difference is there between the pottery of Alcoron and the finest English pottery?

On the one hand, the choice of the clays, and on the other, the same ingredients for the varnish; the oxyde, the dangerous oxyde of lead and the sand, better incorporated, vitrefied, saturated by one another, and, finally, neutralized by their respective attraction, in such a manner that the oxyde of lead cannot obey, as it readily does in its pure state, the solvent action of vinegar, wine, lemons, verjuice, &c. In order to insure the salubrity of these glazings, every thing depends upon applying a greater heat to the pottery, so that the oxyde of lead may be able to dissolve a larger quantity of the sandy part of the surfaces; a solution which it cannot effectuate without a proper degree of heat.

In cases where these surfaces do not afford the sandy parts which the oxyde of lead requires, it is supplied by mixing ground-sand with sulphuret of lead. This is a means whereby the pernicious qualities of this oxyde may be annihilated throughout all Europe. In order to perfect these kinds of pottery, it is not necessary to purchase any secret or particular process; it is not even necessary to watch over the operation. Let the purchase of the fuel be facilitated to the manufacturers, and they will soon know how to bring to perfection what intriguing arts, suggested by interested motives, would wish to make appear very difficult. A manufacturer of this city (Don Esteban Cantelar) has presented to me several specimens of an improved pottery, which have appeared to me to combine all the advantages which are to be desired; of which I have given him my attestation. What is then the cause which could deprive

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deprive the public of the advantages which they might expect from this useful amelioration? We employ daily, with the greatest security, both for drinking and eating out of, vessels composed of lead. The crystal which sparkles upon our tables is composed of it, and the English pottery is glazed only with its oxyde. This oxyde constitutes a part of the covering of our pottery. And why might it not, with equal safety to health, constitute a part of that of the common pottery?

But woe to him who should keep vinegar, wine, and preparations of alimentary or medicinal acids in glazed vessels, the oxyde of which had not been saturated with sand. It is but too true, that it merits the anathema which the most learned physicians of Europe, and among us Dr. Luzuriaga, have fulminated against this oxyde. It introduces itself into vinegar, into lemon-juice, into verjuice, and into the syrups which are made with them, without being perceived.

I have examined verjuice from thirteen different houses in Madrid, and have found only three of them free from any indications of poison, which proved to me that the ten other verjuices had been prepared in Alcorcon vessels. It is true, that none of these verjuices contained a sufficient quantity of lead to raise suspicions in those who might have tasted them. Were that the case, we should have been obliged to give particular directions, instead of the general ones which this essay contains. But as it is of the greatest consequence that those persons who make a trade of preparing acid juices should take the strictest precautions that lead may not, unknown to them, introduce itself into those preparations, I think that they ought to substitute, in the place of the Alcorcon ware, small wooden tubs, or vessels of fine tin, which combine the advantage of cleanliness with that of durability,

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bility, so as amply to compensate for the additional expense of the original purchase.

But as to what respects the preservation of vinegar in the large way, I think that it would be safest to employ for this purpose the same vessels which are used for wine, namely, those of Toboso, and that for the following reasons.

The jars, whose glazing appears to be the most perfect, do not receive in the oven a sufficiently equal and distributed heat with that degree of precision which would be necessary in order that the vitrification should be the same at all points. It is therefore rare that a vessel of this magnitude can have, in this respect, the same uniformity and perfection which we obtain in the smaller vessels. It is therefore to be apprehended, that the vinegar, which penetrates so easily into the cracks of the glazing, may dissolve the portions of oxyde which are not combined, or but very little so, with the sand.

It is also known that the glass of which wine-bottles are made, though the ingredients of which they are composed are better combined, does not resist the acids to such a degree as not to be exposed to corrosion, and even to solution in length of time *. But what is more remarkable, is, that the weakest acids are those which most easily open themselves a passage into these vitreous compositions. Of this the history of chemistry affords us many examples: I shall therefore not advise any one to keep vinegar in glazed jars when he can substitute in place of them other vessels, the salubrity of which is ascertained.

* This happens only when the composition of the glass has been surcharged with lime or oxyde of iron, in order to facilitate its fusion. Note of the French editor.

TO BE CONCLUDED IN OUR NEXT.

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Extract of a Memoir of M. Payssé, *principal Apothecary to the Camp at Utrecht, on the Preparation of some of the Oxydes of Mercury in the large way.*

By M. PARMENTIER.

(Concluded from Page 156.)

Red Oxyde of Mercury by the Nitric Acid.

THIS oxyde, so generally known in commerce by its brilliancy and its beautiful colour, was also one of the preparations which M. Payssé had the curiosity to see performed in Holland, in order to ascertain the means which the manufacturers employ in order to obtain it of a brilliant redness and crystalline appearance, similar, in a word, to that which is manufactured in Germany, and is brought to us, particularly from Nuremberg, from Frankfort, from Basle in Switzerland, and from Triest.

All works of chemistry indicate to us processes for preparing this oxyde; but very few agree respecting the means of obtaining it of a lively and brilliant red. Some, after having effected the solution of the mercury in nitric acid, evaporate it, and expose the matter to a pretty violent fire for some hours, in order to decompose the mercury and convert it into red oxyde; others re-cohobate a certain quantity of nitric acid upon the first solution, dried, and distilled. By repeating this operation several times, M. Chaptal obtained very beautiful crystallized red precipitate*; others, finally, after having dried the nitrate of mercury, incorporate with it a new quantity of running mercury, expose the mixture, well made, to a brisk heat, of an obscure redness, between two crucibles, luted together; and in this manner M. Van Mons

* See his Elements of Chemistry, article Mercury.

asserts

asserts that he has very easily obtained the red oxyde of mercury perfectly crystallized *.

All these processes, though accurately described, are not however sufficient to the person who should wish to perform the operations upon a large scale, or to make the application of chemistry to the arts which depend upon it. It requires the experience of the large work-shops, the habit of the operations of great laboratories; otherwise one does not succeed till after having made many frequently ruinous and discouraging trials.

M. Payssé has frequently employed in his experiments the different methods of which we have just spoken; he has proceeded with all the accuracy to which the desire of succeeding in such an operation gave rise, yet he never obtained results so satisfactory as he hoped; he adds, however, that the means proposed by M. Chaptal were those from which he obtained the most constant success, although it was not complete. He varied his processes by employing the nitric acid in different proportions, and also of very different degrees of density and purity; but it was never possible for him, notwithstanding the quantity of crystallized oxyde which he obtained, to account very accurately to himself for the phenomena which cause so many variations in the results of this operation, which in appearance is so simple, and which nevertheless cannot be executed without many difficulties. It requires so much care and management in the application of the heat which one is obliged to employ, that in two operations, in which every thing was disposed in the same manner, in which all the circumstances appeared entirely

* Journal de Physique and de Chimie, de Van Mons; Memoirs by Messrs. Fischer and Lichtenberg, Pluvoise 15, year 10, page 211, and Brumaire 15, year 12, p. 178.

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similar, his results were almost always different. Sometimes one of the apparatus contained a portion of crystallized oxyde, whilst the other part was a brick-red powder, without brilliancy; sometimes the whole of the oxyde of one of the vessels was converted into fine crystalline precipitate (red oxyde of mercury), and that of the neighbouring vessel, which had been treated in the same manner, presented only a mass, half yellow and half red, without appearance of crystallization; sometimes the two apparatus presented only this oxyde converted in part into brilliant oxyde, whilst the rest was of a disagreeable red; finally, sometimes, the one contained this oxyde presenting three very distinct colours, the bright red, the red inclining to the brown, and the orange.

The second apparatus presented only an oxyde with two very distinct colours, the orange and the brick-red, without brilliancy. Where, says M. Paysse, shall we look for the cause of these anomalies, if it is not in the manner of evaporating the solution, and especially that of decomposing the metallic nitrate during the whole course of the operation? We shall, however, see that the purity of the nitric acid contributes also very considerably to render difficult the conversion of the mercury into crystallized red oxyde, and that the muriatic acid with which the former is constantly mixed in that of commerce, presents a powerful obstacle when it exists in it in too large proportions.

When mercury is dissolved in nitric acid mixed with muriatic acid, there is almost always formed a white precipitate, which is the more abundant in proportion as the quantity of the latter acid is larger. Without stopping now to determine the real nature of this precipitate, M. Paysse considers merely the part which this compound acts in the oxydation which it is endeavoured to make

mercury

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mercury undergo, by decomposing the nitrate of this base by the action of fire.

If we expose to fire nitrate of mercury obtained from a solution of this metal in the nitric acid, mixed with muriatic acid, this salt first loses its water of crystallization; it is afterwards decomposed, letting escape a portion of acid which existed in it in excess, and which may be collected in a convenient apparatus, since it has experienced no alteration: to this disengagement succeeds that of the gaseous nitrous acid, which manifests itself by very elastic red vapours. This acid gas is almost always mixed with oxyde of azote, or else this follows the disengagement of the former. These two gasses indicate the decomposition of the nitric acid, and the loss in favour of the mercury of the oxygene which causes the nitric to pass into the state of nitrous or of oxyde of azote. When the application of the fire is continued, the last portions of the nitric acid abandon the mercury, and this is converted into an oxyde more or less saturated with oxygene, because in fact this state is always dependant upon the quantity of calotic which is accumulated upon this substance during its transition into that of red oxyde.

It is when the vapours of nitrous gas cease, that the oxyde changes colour; it passes successively from the white to the yellow, and from the orange to the red, more or less intense. It is commonly when the red is very vivid and beautiful that the vessel is removed from the fire, and the mass is preserved either in that state or reduced into powder.

It seems, at first sight, that an operation, conducted as has just been indicated, ought to give, as its constant product, a well crystallized oxyde; and this in fact happens, 1, when the nitric acid is free from muriatic acid, or when this exists in it in very small quantity; 2, when its

its density is equal to thirty-four and thirty-eight degrees; 3, when the desiccation and the decomposition of the metallic nitrate are effected slowly, and in an uniform manner; 4, when the heat applied towards the end of the operation, and whilst the last portions of acid are disengaged, has been well graduated, and kept always nearly at the same degree; for if, as many practitioners are in the habit of doing, and as sometimes has happened to M. Payssé, we heat the oxyde too rapidly at the moment when it acquires its fine colour, as well as its brilliancy, it not only loses its crystalline appearance, but it also assumes a disagreeable brown-red tinge; nay even, if this application of heat were carried farther, it would at least be disoxygenated partially, if not completely, and the mercury in this case would resume its original form, as the author has had occasion to observe under various circumstances.

If the quantity of muriatic acid with which the nitric acid is mixed is too considerable, and amounts to several hundredths of the dose employed, the peculiar compound which results from its union with the oxyde of mercury assumes not the characters of a simple super-oxygenated muriate, as might at first be presumed, but those of a new compound, which dissolves only in very small quantity in water (and even then the water must be boiling), which sublimes by itself in close vessels, assuming, or rather retaining, its peculiar colour, which is a brownish red, without appearance of crystallization, and which M. Payssé considers as a muriate of mercury with excess of oxyde, according to the results which it has given him when subjected to some experiments.

When this compound exists in too large a proportion in the oxyde of mercury which is prepared, it always opposes the formation of the crystallized red oxyde, as he

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he has remarked a great many times in his experiments; if, on the contrary, it is contained in it only in a small proportion, it may be neglected, nay, it even separates itself from the rest of the oxyde in the vessel in which it is prepared, occupying a line, and forming a detached stratum towards the upper part of the mercurial mass.

What M. Payssé has shewn relative to the advantage which arises in the preparation of the red oxyde of mercury by the nitric acid, from employing an acid as free as possible from muriatic acid, he had remarked in the experiments which he made every year in his course of chemistry; but not being able to rest a very just opinion upon the results of some trials made on a small scale, he wished, previous to developing it, to observe with attention what passes in the great operations which are practised in the manufactories, where considerable masses are acted upon at the same time. Now that all his doubts on this subject are removed; and as he is acquainted with the phenomena which take place when several hundred kilogrammes of mercurial oxyde are treated in one operation; the quality of the nitric acid that is employed, and the method to be followed in the application of the heat, during the whole course of the operation, the author is able with certainty to indicate a process for obtaining this oxyde possessed of all the qualities which are desired and esteemed in these preparations.

Take mercury, exempt from all other metallic matter, 50 kilogrammes; nitric acid, deprived as much as possible of muriatic acid *, indicating by the areometer for acids

* It may be tried by the nitrate of silver, and if the quantity of muriatic acid appears small, it may be neglected. However it sometimes happens, especially when the nitric acid is too weak, or when it is not in

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acids from 34 to 38 degrees, 70 kilogrammes; dissolve the metal in the acid, and aid their reciprocal action by a gentle heat in the sand-bath *; evaporate by distillation; remove the recipient from the retort when the vapours of the nitrous gas begin to manifest themselves; they announce the decomposition of the mercurial nitrate. It is here that we must make use of a constant and moderated temperature, if we wish to ensure the success of the operation; it is raised a little towards the end, that is to say, when the disengagement of the gaseous nitrous acid manifests itself only in a little sensible manner; the vessel must be kept at this degree of heat till it is perceived that the mass of mercurial oxyde is of a lively and brilliant red in all its parts. An application of fire for eight

in sufficient quantity, that the mercury precipitates itself in the state of white oxyde as fast as it is formed, because it cannot be held in solution either by the water or by the remaining acid; besides which, the non-oxydated mercury continually exerts a chemical attraction upon one of the principles of the acid, and the latter tends rather to be decomposed than to dissolve the mercury which is already saturated with oxygene to a certain point; so that we must take care not to confound this property with that of the muriatic acid: moreover the precipitate, which is only the effect of the oxydation of the mercury, dissolves entirely in the heated nitric acid, whilst the other can dissolve in it only in very small quantity; this property alone would be sufficient to distinguish it. I might have dispensed with making this observation, since in my process I require a highly-concentrated and very pure acid; but as it frequently happens that one has not one so strong, we may then supply it by the quantity, and my remark in this case will not be superfluous. (Note of M. Paysse.)

* This solution ought to be made in a retort of glass, with a wide bottom. This vessel is preferable to the mattrass which is used in Holland, as it is only required to adopt a recipient to it, and to distil, in order to collect the acid which is not decomposed upon the metal. This object is by no means to be neglected in operations on a large scale. (Note of M. Paysse.)

hours

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hours is generally sufficient for 200 kilogrammes of this substance.

It has been observed elsewhere, that the turf which is used in the manufactories of this country presents some advantages over other combustibles; and this is true, for we may easily obtain an equal heat, because this matter burns slowly, and in a very uniform manner.

As the charcoal of wood, or that which is found in the earth, are the two combustibles which are employed the most frequently in France, none of the circumstances of which we have spoken ought to be neglected.

When all the precautions indicated have been vigorously observed, it is rare that we do not succeed in obtaining oxyde of mercury by the nitric acid, of a brilliant redness and well crystallized.

If, notwithstanding all the care that has been taken, the mercurial mass should not have the proper brilliancy, or should not present the crystalline aspect which is required, it would then be necessary to reduce it into coarse powder, to introduce it into a new glass vessel, into which some cubic centimeters of nitric acid had previously been put, only in order that we might be able slightly to impregnate, by heating in the sand-bath, all the not brilliant oxyde. One or two hours application of fire with this apparatus would then be sufficient for converting the oxyde into crystallized precipitate.

On reviewing what has just been said respecting the method of preparing the red oxyde of mercury by the nitric acid, we see that the conditions, indispensably necessary for obtaining it constantly brilliant and crystallized, are,

1. To make choice of a nitric acid free from mixture with muriatic acid; 2, to employ this acid at the degree of concentration already indicated; 3, to evaporate the

metallic solution with a moderated heat; 4, to employ a vessel with a bottom sufficiently wide for the mass of oxydated mercury to present much surface, and to be easily heated in an equal manner in all points at the same time, in order that the nitrate may be uniformly decomposed, and pass as speedily as possible into the state of red oxyde; 5, to augment the heat gradually, and in proportion as the decomposition of the nitrate advances; 6, to sustain this temperature at the same degree during the whole time that the operation lasts, that is to say, the transition of the yellow oxyde into the red which is required.

"I am very far from believing," says M. Payssé, "after my experiments, and those which I have seen performed in the large way, that the crystallized red oxyde of mercury owes its brilliant appearance to a state of semi-vitrification, as M. Van Mons thinks *; for if this oxyde were really semi-vitrified by this operation, it would follow that a more elevated temperature would be capable, nay must necessarily convert it into glass; but nothing of the kind ever happens; for I have heated very strongly, and at several times, four grammes of this oxyde well crystallized, in two crucibles luted together, when, instead of being vitrified, it lost not only its brilliancy, but also its fine red hue, and acquired a disagreeable brick colour. When a still stronger heat had been applied, a great part was found reduced, and the rest of the oxyde had acquired a deep brown colour.

"I am however aware, that there are bodies which are not susceptible of passing into a complete vitrification, and which nevertheless experience, at a certain degree of heat, a pastey fusion, which is called semi-vitriform;

* Journal de Physique de Chimie, years 10 and 12, pp. 178 and 211.

but

but when the oxyde of mercury is heated in transparent vessels, nothing of the kind is seen to take place, we do not perceive the least trace of a partial or general softening of the mass: besides, I have strong grounds to believe, that the crystalline state of the mercury, oxydated by the nitric acid, is owing merely to the degree of oxygenation of this metal, and to the uniform manner in which the oxydating principle combines with the mercury during the decomposition of the nitrate of this base, and its conversion into red oxyde."

The experiments upon this substance not being yet terminated, M. Payssé has promised to continue them, and to send me the results without delay, which I shall consider it equally a duty and a pleasure to communicate to the public through the medium of this journal.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

Ballinasloe Farming Society.

THE fifth annual show of breeding stock since the commencement of the institution lately took place here. The improvement has been progressive, and has surpassed the most sanguine hopes of the Society. The young stock appeared far superior to those from which they were bred, which is to be attributed to judicious selection, and the soil and climate of Ireland, so favourable to cattle: a few excellent specimens were exhibited, the produce of a single cross on the native breeds. Five distinct varieties of neat cattle appeared, each contending for a decided superiority over all the rest. Such a competition, repeated for a series of years, must ultimately

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mately overcome prejudice, and determine which is best. The sheep were excellent in their kinds; the new Leicesters still hold their place as the most profitable for the low-land pastures, and the South-Down for the upland districts; the latter were much better than any hitherto produced, and some were deservedly admired. There were also some fine-woolled sheep, by Spanish rams on Ryeland ewes. More attention than usual was paid to the quality of the different kinds of wool. The judges were gentlemen of experience, and they were assisted by a professional man.

The only draft stallion exhibited was a Suffolk punch. Nothing is more wanted in Ireland than an improvement in horses; and this breed being strong, active, and spirited, promises to be an acquisition. The improved breed of swine have spread through every part of Ireland, and are likely soon to displace the awkward unprofitable animal which was a disgrace to the country.

Extraordinary Produce.

In spring last, a single pea had dropped accidentally in the garden of Clay-potts, Perth, possessed by Mr. James Laird; the produce of which was lately pulled, and the pods carefully counted, to the amount of 299, exclusive of a great number which had been previously devoured by birds. On an average, each pod contained four peas, so that the total produce was nearly 1,200 grains.

There was taken up in a garden in the Black-Friars, Perth, a potatoe which weighed 2 lb. 4 oz. There were besides, at the same root, several others larger than the common size, and a number of smaller ones. What is deserving of notice, it was of the spotted Virginia kind, a species which seldom grows to a great bulk, and was

not

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not planted, but produced from a potatoe that had been left in the ground last year. From another root, produced in the same manner, were taken up ten potatoes, some of which weighed a pound and a half, and weighed together nine pounds, besides six others of an ordinary size.

Cheviot Sheep,

It is hardly to be credited how much this excellent sort of sheep has been improved by the various breeders who have directed their attention to that object, both on the borders and in the Northern parts of Scotland. The excellence of their fleece is well known, and the shape and size of the carcase have been so much improved as to fetch, when fully fed, as high a price as three pounds each. A wether of the pure Cheviot breed was exhibited and killed for the show of sheep held at Camp-House, near Edgerton, on the 4th of September last, and weighed as follows;

		stone.	lbs.
Live weight		13	0
Dead weight,	The four quarters	7	12½
	Tallow	0	17½
	Blood	0	7½
	Entrails	1	0
	Head and feet	0	9½
	Strap	0	7
	Skin	0	13½

This sheep was bred at a farm called Langwall, in Caithness, and was bought by Mr. George Currie, of Hallrule, near Jedburgh, on the 15th of October 1802, at two years old. The price was at the rate of 1*l.* 6*s.* As soon as bought he was laid upon turnips, and kept on them for twenty-six weeks; he was afterwards put on common pasture with the farmer's stock sheep; again put

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put on turnips about the 1st of November 1803, and kept on them till the beginning of April; and then kept, with the other stock sheep, on common pasture till he was killed. No particular attention was paid to feeding him high; but, as he throve well, Mr. Currie thought it would be right to bring him to the show, that it might be seen to what perfection the breeding of the Cheviot sheep was brought in the North.

Specimens of the Leicester, the South-Down, the Border Cheviot, and the black-faced, or forest breeds, were exhibited at Camp-House at the same time, none of which seemed to give greater satisfaction than the above-described.

Meteorology.

Depth of rain fallen in Liverpool during 1804, and amount of water evaporated out of a vessel four inches diameter, placed out of the reach of the solar rays, or influence of fire.

	Fall of Rain	Evaporation of Water, &c.
Amount continued from vol. V. p. 319, Jan. and June inclusive	Inches. 12,66	Inches. 11,4
July	1,9	3,3
August	2,35	3,
September	1,67	2,12
October	5,90	1,75
November	3,	1,35
December	2,40	1,50
Total	29,8	24,32

As measured by G. J. Liverpool.

List

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List of Patents for Inventions, &c.

(Continued from Page 160.)

JOHN EDWARDS, of Bow-street, in the county of Middlesex, Currier and Harness-maker; for improvements in fire-places, calculated to save fuel, give a more general heat, and prevent chimnies from smoaking. Dated December 4, 1804.

MATTHEW GREGSON, of Liverpool, Upholder; for a method of cleaning feathers for beds, and hair, wool, down, and other the natural covering of birds and animals, from their animal oil, in the most perfect manner, and in such a way as to render them more healthful, sweet, and pleasant for use. Dated December 4, 1804.

STEPHEN PASQUIER, of Wilderness-row, Charterhouse-square, in the county of Middlesex, Professor of Languages; for his new-invented manufacture, system, or method of writing, printing, engraving, drawing, painting, stamping, working, and using, certain characters, figures, instruments, and machines, for facilitating correspondence and other literary operations. Dated December 19, 1804.

WILLIAM EVERHARD, Baron Von Doornick, of Wells-street, in the county of Middlesex; for certain compositions formed by uniting an absorbent or detergent earth with other ingredients, so as to render the same more effectual in washing or scouring, and for various purposes to which soaps or detergent earths are now applied. Dated December 19, 1804.

JOSEPH WILLIAM MAYER, of Soho-square, in the county of Middlesex, Esquire; for improvements upon bitts of bridles. Dated December 19, 1804.

SAMUEL

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SAMUEL GUPPY, of the city of Bristol, Merchant; for additions to, and improvements on, machines for cutting, heading, and finishing nails, and the mode of working thereof. Dated December 19, 1804.

SOLOMON HOUGHAM, of Aldersgate-street, in the city of London, Goldsmith; for his new-invented spring-clasps for buckles, lockets, and other ornaments of dress. Dated December 19, 1804.

THOMAS MARGRAVE, of the parish of Saint Mary, Whitechapel, in the county of Middlesex, Silk-throwster; for his new-invented mills and machinery, upon a new and improved construction, for throwing, spinning, doubling, and twisting silk-thread, cotton-thread, flax-thread, hemp-thread, and all such other articles as usually are or may be thrown, spun, doubled, or twisted. Dated December 19, 1804.

JOHN GOVER, of Rotherhithe, in the county of Surrey, Gun-carriage-maker; for improvements and additions in the construction of a certain carriage for all sorts of cannon. Dated December 19, 1804.

RICHARD WILLCOX, of the city of Westminster, Engineer; for his new-invented machinery for more expeditiously cutting, stripping, or plucking, the various furs of beavers, seals, wool, hair, &c. from the various skins now plucked or stripped by hand; and for sundry methods of preparing and cleansing the said skins. Dated December 19, 1804.

EDWARD STEERS, of the Inner Temple, Esquire; for his new-invented engine, producing a force by the impetus which the parts of a fluid body have to an equal altitude, applicable to the working of all sorts of machinery. Dated December 19, 1804.

ABRAHAM UNDERDOWN, of the parish of Eling, in the county of Southampton, Gentleman; for a method of making flour without grain. Dated December 21, 1804.

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THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. XXXIV. SECOND SERIES. March 1805.

Specification of the Patent granted to THOMAS PORTHOUSE, *of Hall Garth, in the Parish of Houghton-le-Skern, in the County of Durham, Flax-spinner; for a Machine for hackling Flax and Hemp, and at the same Time carding the Tow.* Dated October 6, 1804.

With a Plate.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Thomas Porthouse do by these presents describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, by the annexed drawing, (Plate XI.) and the following description thereof; that is to say: The machine consists of the following parts. Part the first, which I call jaws, (see Figs. 1 and 2,) for fixing or holding one end of the handful or parcel of the flax or hemp in a firm manner, whilst the opposite end of the handful or parcel of flax or hemp undergoes the subsequent operation of hackling. Part the second, which I call a turn-table, on the edge of

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which the jaws are fixed, (see Figs. 3 and 4,) for introducing into the machine the handfuls or parcels of hemp or flax in the raw state, also for changing the side of the flax or hemp during the operation; and when the handfuls or parcels of flax or hemp become sufficiently dressed for turning them out of, or from, the acting part of the machine, for the purpose of allowing the handfuls already dressed at one end to be taken out of the jaws, and changed or turned to the contrary end, or replacing them by undressed handfals, as the case shall require. Part the third, an instrument, which I call a porcupine, (see Figs. 5 and 6,) for dressing or splitting the fibres of the flax or hemp, and at the same time taking out the tow or shorts from the staple flax or hemp, and delivering it upon small conical cards, for the purpose of carding the same, in a manner herein-afterwards to be described. Part the fourth, conical or bevel-faced cards, (see K, Figs. 9 and 11,) for receiving the tow from the porcupine, and carding the same, which is afterwards collected by rollers, nearly in the same manner as from the common carding-engine. Part the fifth, machinery for giving the requisite velocity to each of the foregoing parts of my said machine (see Figs. 11 and 9).

The jaws (see Fig. 1, Plate XI.) are made of cast-iron, or other metal, and represented as open, ready for receiving the handful of flax or hemp.

Fig. 2, shews how the flax or hemp is fixed into the jaws ready for the subsequent operation of hackling or dressing. Three of these jaws are fixed upon the edge or outer rim of the turn-table, at equal distances from each other.

In Fig. 3 two jaws are represented, in which A shews the jaws open, and B the jaws shut, with the flax or hemp in them. C the table, which is made of wood or metal,

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metal, about three feet diameter, and mounted upon an iron shaft, having three studs Z Z Z, (see Fig. 4,) of iron, about three-fourths of an inch diameter, firmly fixed in their upper side at about six inches distant from the centre, and equi-distant from each other, and projecting about two inches. Several of these turn-tables are placed at convenient distances, and ranged in a circular direction round one common centre, as represented in Fig. 4, suitable for being acted upon by the porcupines D, more particularly delineated in Figs. 5 and 6; in which D is the body or barrel of the porcupine, made of wood, and about nine inches long and six inches diameter, stuck or filled with steel pins E, similar to those used in the common hand hackle, and projecting in radii from the body or barrel of the porcupine, of different lengths and fineness, to suit the flax or hemp as the dressing advances in fineness during the operation. Those pins which are intended to strike the raw flax or hemp in the first instance, are about two inches in length, and set in the barrel or body of the porcupine at about the same distance as those used in the hand hackles for flax or hemp of the same kind, and gradually increase in length and fineness round the whole of the circumference of the barrel or body of the porcupine: the longest pins are about a quarter of an inch longer than the shortest, and the finest pins are set about the same fineness as those used for finishing the same kind of flax or hemp by hand. And as the tow is collected upon the pins of the porcupine, the pieces or bars of iron or other metal F, called droppers, (about one inch broad, a quarter of an inch thick, and nine inches in length, placed in a longitudinal direction amongst the pins of the porcupines,) drop down upon the tow; and as the porcupine revolves round its own axis these droppers, by their own weight, drop down, and gra-

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dually push the tow from the points of the pins as they advance in their progressive motion round their own axes, but are prevented from falling too far by a plate at each end of the porcupine, about ten inches diameter, and one-eighth of an inch thick, having grooves cut in it, in which the ends of the droppers slide, as represented in Fig. 8; in which G is the plate, H the grooves, I a dropper, falling down and pushing off the tow, and J the dropper restored to its place, and leaving the pins at liberty for acting in the hemp. The tow thus pushed off the pins of the porcupine is collected by the conical cards, as represented in Figs. 9 and 11, in which K is a conical barrel, about twelve inches long and about fifteen inches diameter at the thickest end, and ten inches at the smaller end, covered on its superficies by a card of the usual fineness for carding tow, and placed with its smaller end towards the centre of the machine, as represented in Figs. 9 and 11; and its upper side a little lower than the under side of the porcupine, for the purpose of collecting the tow from the lower side of the porcupine, as the same is pushed off by the droppers, and ought at these dimensions to make about five revolutions *per* minute.

L, Fig. 10, is a fixed angular piece of wood, (its base about fifteen inches in length and six inches in breadth, and its height about ten inches,) which I call a preventer, placed close to the superficies of the conical card K, the side of which angular piece of wood next the card K is curved so as to fit the card K, and extending over about a fifth part of its surface, serves to keep the tow from escaping from the card K until it arrives at the angle M, where it is received by the main bevel card wheel N, Figs. 9, 10, 11, in which O are the cards, as they are placed upon the bevel of the wheel, leaving open spaces between the cards for the purpose of letting out the dust.

This

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This wheel N is about six feet diameter, and revolves at the rate of about sixty revolutions *per* minute, and receiving the tow from the conical cards K at the angle of the preventer at M, it is thereby carded as it passes between them; and the lower side of the preventer being lined or covered with a card, whose hooks point in a contrary direction to those of the cards on the main bevel card wheel, assists in carding the tow, and serves also to keep it close and compact into the cards O.

P, Figs. 9 and 10, represents a conical brush, twelve inches long, twelve inches diameter at the largest end, and nine inches diameter at the smallest end, its bristles pointing in radii from its centre, and its axis pointing in a line towards the centre of the machine. The superficies of the brush act upon the main card, and ought to move with a velocity of about one-fifth quicker at its surface, for the purpose of raising up the tow from the hooks of the main card, in order that it may be received from the conical doffing card Q; Figs. 9 and 11. This card is about thirteen inches long, eighteen inches diameter at the largest end, and eight inches at the small end, and placed with the largest end towards the centre of the machine. The hooks of the card must point in a contrary direction to those of the main card; and in proportion thereto ought to make about ten revolutions *per* minute, by which, as it is going slower than the main bevel card wheel, which is acting against it, the tow is caught upon its hooks, and may be collected therefrom in a continued sliver by cylindrical rollers, whose superficies move with an equal velocity with the superficies of the larger end of the conical doffing card Q, nearly in the manner as is usually done from the cylinders of the carding-engines now in use.

The

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The movements for the different parts of this machine may be obtained in various ways; that which I have adopted is as follows. In the centre of the machine, of which Figs. 4 and 9 are plans, and Fig. 11 an elevation, I place an upright shaft of iron R, about six or seven feet long and about three inches thick, resting in a step of metal at the bottom end, and supported at the upper end by a wood framing to keep it steady, but so as the shaft itself may be easily turned round therein. At the upper end of the shaft R, I fix a pulley S, by which this shaft is put in motion by a strap leading from the mill. Near the middle of the shaft at R is firmly fixed thereon a strong cast-iron frame, for receiving three spindles, a plan of which is delineated in Fig. 7, in which T T T represent the cast-iron frame, and U U U the spindles, D D D the porcupines, firmly fixed upon the ends of the spindles U U U, but the spindles themselves are not fixed fast, but are at liberty to move round upon their own axes. By the motion of the shaft R round its own axis, the frame T T T, and the spindles U U U, and the porcupines D D D, placed thereon, are carried round in their orbit at the speed of about sixty revolutions *per* minute, by which means the three porcupines D D D, striking alternately against the handfuls of flax or hemp presented to them by the turn tables C, Figs. 4 and 11, split the fibres of the hemp or flax, and at the same time collect the tow or shorts upon the pins of the porcupines, which is again collected therefrom by the conical cards for carding the same, as before described. Upon the spindles U U U are bevel-toothed wheels V V V, whose teeth are inserted between and are acted upon by the teeth of a similar wheel W, placed upon a round part of the shaft R, but whose motion round its own

axis

axis is slower than the shaft R, in the proportion of about twenty for the shaft R to one of the wheel W; by which means the wheel W becomes so nearly stationary as to act upon the wheels V V V nearly as a fixed or dead wheel would act, thus producing a rotary motion to the spindles U U U and the porcupines D D D, as they are carried round by the frame T T T upon the shaft R; and by this means the porcupines D D D, presenting a change of surface to the flax or hemp which gradually passes from the coarser set and short pins towards the longest and finest set pins, until the pointer wheel, hereafter to be described, and the wheel W, to which it is fixed, has made one entire revolution, which in general may be about twenty revolutions of the main shaft R; but this must be varied according to the quantity of flax or hemp to be hackled, and is done either by changing the wheel X, Figs. 4 and 11, or altering the diameters of the pullies Y and *a*, Fig. 11; coarse flax or hemp requiring fewer strokes of the porcupines, and fine flax or hemp requiring more, and which is to be adjusted by the operator. This rotary motion of the porcupines also presents a continued change of their surface to the conical cards K, and produces an alternate motion to the droppers F, Figs. 5 and 6, by which means the tow is thereby pushed out from amongst the teeth of the porcupines, and is collected by the conical cards K, as before described. Upon the upper side of the wheel W, Fig. 11, is firmly fixed a socket of metal; and upon the upper end of that socket is also firmly fixed another wheel *b*, about thirty inches diameter, which I call the pointer wheel, whose teeth are inserted between and are acted upon by the teeth of the wheel X, whose diameter is about one inch and a half. This wheel X is firmly fixed upon a spindle *c*, upon which is the pulley Y, which by a strap

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a strap from the pulley *a* upon the shaft R has its relative motion given to it; which motion may be varied by changing the wheel X, or changing the diameter of the pullies Y and *a*, or by making these pullies into cones, reversing the ends of them, and sliding the strap by a lever, for that purpose, to the upper or lower end of those cones. Upon the lower side of the wheel *b* is firmly fixed a bar of iron *d*, Figs. 4 and 11, which I call a pointer, projecting in a radical line from the centre of the wheel *b*, and extending itself out nearly to the centre of the turn-table. This pointer is for the purpose of pushing the turn-tables round upon their axes by its action against the pins Z Z Z, and by this means changing and turning the handfuls of flax or hemp as before described, and according to the velocity of this wheel *b* and pointer *d*, which may be varied as before said by a change of wheels, or by sliding the strap along the cones, such will be the number of strokes given by the porcupine against the flax or hemp, and thus may the fineness of the cut be regulated. Upon the shaft R, Figs. 9 and 11, a little below the cast-iron frame, is firmly fixed an endless screw *e*; and upon the spindles *f* are also firmly fixed spur wheels *g*, having eighteen teeth, which teeth are inserted between and are acted upon by the worm or threads of the screw *e*, which, by the revolution of the shaft R, gives motion to the spindles *f* and the conical cards K (fixed firmly thereon), in the proportion of three and one-third revolutions of the conical card K to sixty revolutions of the shaft R, as before described. Near the lower end of the shaft R is firmly fixed thereon the main bevel card wheel N; and a little above that wheel, is also firmly fixed upon the shaft R a bevelled-toothed wheel *h*, about twenty-one inches diameter; and upon the spindle *i*, Fig. 9, is also firmly fixed another bevelled-

toothed

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Fig. 1.

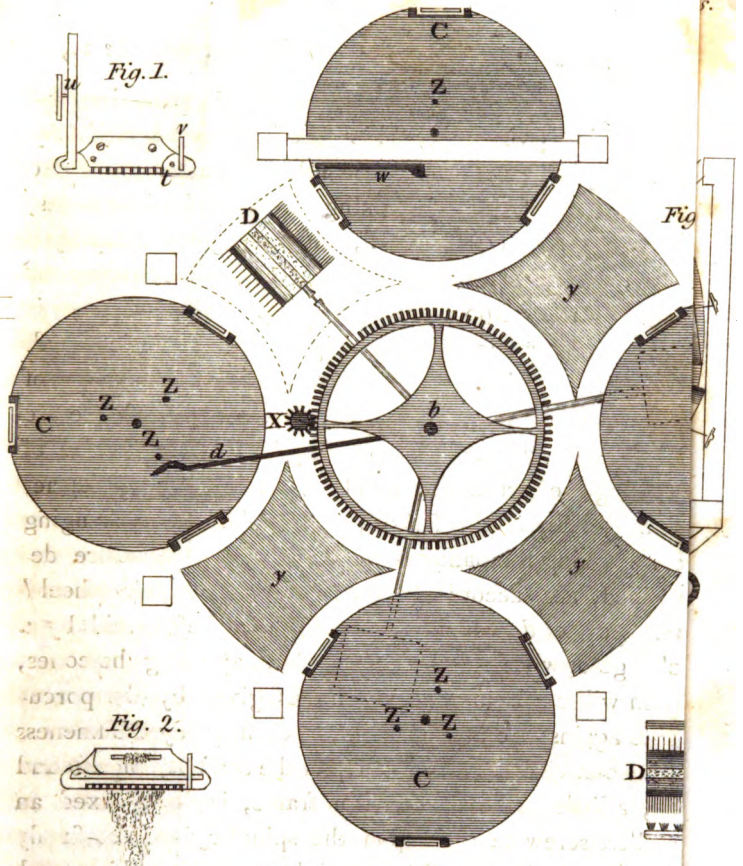
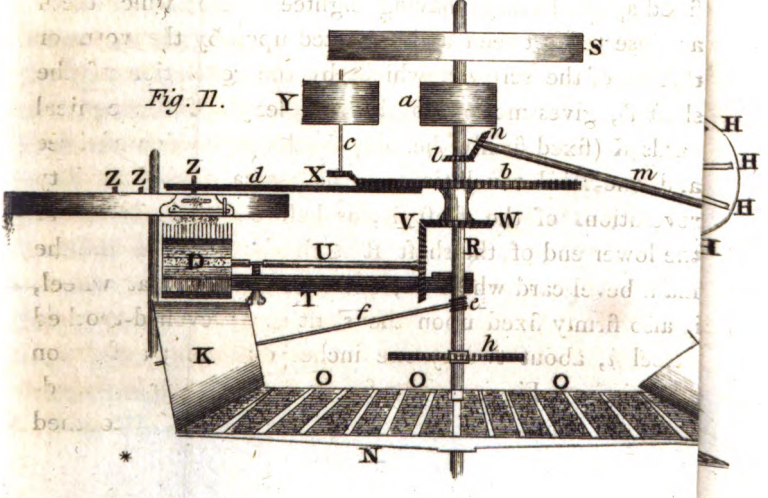


Fig. 2.

Fig. II.



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toothed wheel *k*, about three inches diameter, the teeth of which are inserted between and are acted upon by the teeth of the wheel *h*, which, by the revolution of the shaft R, gives motion to the spindle *i* and the conical brush P, firmly fixed thereon, in the proportion of four hundred and twenty revolutions of the conical brush P to sixty revolutions of the shaft R and the main bevel card wheel N, as before described. Upon the shaft R, and a little above the wheel *b*, is firmly fixed a small bevel-toothed wheel *l*; and upon the spindle *m* is also firmly fixed another similar bevel wheel *n*, the teeth of which are inserted between and are acted upon by the teeth of the wheel *l*, which, by the revolution of the shaft R, gives motion to the spindle *m*, which also in the same manner gives motion to the rollers *o o*, and rollers *p q*. The roller *p*, by a wheel fixed firmly upon its lower end, also gives motion to the wheel *r*, which, being likewise firmly fixed on the spindle *s*, gives motion to the conical doffing card Q, in the proportion of ten revolutions of the doffing card Q to sixty of the shaft R and main bevel card wheel N fixed thereon, as before described.

The machine thus in motion, and the turn-tables adjusted by the screw on which the foot or lower axis of the turn-table rests, so as the porcupines just pass clear of the under-side of the tables; and the porcupines having been adjusted by screws under their pivots, so as their lower sides pass just clear of the conical cards K, those jaws which are outside the machine must be fed with handfuls or parcels of flax or hemp, of two, three, four, or more ounces each, according to the quality of the flax or hemp, by taking the parcel to the turn-table, and after opening the upper jaw, which is notched in the same manner as the under jaw, (see *t*, Fig. 1,) for the

purpose of keeping the flax or hemp spread broad, fold one end of the flax or hemp over the head or cross part of the jaw, and two or three times round the part *a*, and then press down the jaw within the hook or catch *v*, it will be holden firmly. This done, the pointer *d* will move the turn-table forwards one-third of a revolution, and thus draw the handful or parcel of flax or hemp within the orbit or circular range of the porcupines; and the turn-tables being held fast by catches, as at *a*, see Fig. 4, where one only is represented, the points or pins of the porcupines striking against the parcels of flax or hemp, and at the same time prevented from going too deep by the fence or foreboard *x*, (see Fig. 1,) the top edge of which is to be level with the points of the short pins of the porcupines, will gradually begin to dress or hackle the same, which, after receiving about twenty strokes from each porcupine, the pointer will have again advanced to that turn-table which it first began with, and by its action loosening the catch *w* the turn-table will be again driven one-third of a revolution round its axis, and the handful of flax or hemp will advance forwards, and present its other side to the action of the porcupines; but in this instance, as the stroke of the porcupine impels the handful or parcel of flax or hemp from or beyond the superficies of the turn-table, there are fixed what I call end boards, see *y*, Fig. 4, to prevent its escape from the action of the pins of the porcupines. (One of the end boards is omitted in the drawing to shew a porcupine). After receiving about twenty more strokes from each of the porcupines, the turn-tables will be again pushed forward by the pointer, the remaining third of a revolution round its axis, and the handful of flax or hemp which was first affixed to the jaws, will make its exit from the machine, having one end, or half of it, completely

finely hackled, which, when the operation is repeated at the other end of the handful, will be finished; and its tow or shorts being received by the conical cards K will be carded by the card N, and delivered by the conical doffing card Q and rollers *p p* and *q q* in a continued sliver, as before described.

Upon a part of the iron frame T T T, Fig. 7, are fixed three narrow brushes, about nine inches long, placed with the ends of the bristles downwards, and rather lower than the pins of the porcupines D, and about three inches behind them, (see *z z z*), for the purpose of assisting the separation of the tow from the pins of the porcupines, and sweeping it into the teeth of the conical cards K.

Fig. 12, is an iron frame, to be fixed upon the long rails in Fig. 9, for the purpose of supporting the axis of the conical cards K and the axis of the conical brushes P.

The machine must be cased to keep in the dust, and the spindles and pivots must be secured from the short fibres which fly off in working.

In witness whereof, &c.

Specification of the Patent granted to EDWARD STEERS, *of the Inner Temple, London, Esquire; for his Invention of an Engine producing a Force by the Impetus which the Parts of a fluid Body have to an equal Altitude, applicable to the working of all Sorts of Machinery.*

Dated December 19, 1804.

With a Plate.

TO all to whom these presents shall come, &c.

NOW KNOW YE, that in compliance with the said proviso, I the said Edward Steers do hereby declare and describe my said invention to be an engine which contains a new method of giving activity to a body of water, or other

liquid contained in it, so as to produce a force from the well-known property of the pressure of liquids in all directions, which may be conveniently applied to the purpose of working machinery. The method consists in suddenly producing or increasing an inequality in the altitude of the parts of the fluid body contained in the engine by the descent and ascent of a pipe, cylinder, or other vessel capable of holding liquid, by either turning on a hollow projection, joint, or water way, which connects it with another cylinder or vessel, as in the drawing Fig. 1, (Plate XII.) or by turning in an orifice of the other cylinder or vessel, or by having a flexible pipe or sliding pipe, (similar to the joints of a telescope,) or other water way, connecting it with the other cylinder or vessel, so that it can be raised and lowered, as represented by Fig. 5.

DESCRIPTION OF Fig. 1.

a, is a cylinder, open at the top. *b*, is another cylinder, closed at each end, which exactly fills the cylinder *a* with respect to its width, so that no liquid can pass between them. *c o*, is a long pipe, curved at the end *c*, to prevent the escape of liquid, the end *o* turning on a hollow joint or water way into the cylinder *a*. Perhaps it would be better to have the end *o* of the pipe straight, and inserted in an orifice of a box or chamber, made to turn on the water way *d*. *e*, is a support, with a hole in it, to receive a pin fixed at the lower end of the pipe *e o*, (or in a box or chamber in which the end *o* of the pipe is inserted,) that it may the more easily turn on *d*. *fff*, are supports for the whole. Let the pipe *c o* be lowered to a horizontal position, and let water be poured in at the end *c* till the pipe be full; then if it be raised again perpendicularly, the water will run into the cylinder *a*, and by its pressure raise the cylinder

linder *b* with a very powerful force, which may be applied to the working of all sorts of machinery. When the pipe *c e* is again lowered to a horizontal position, the water will run from the cylinder *a* into the pipe, and the cylinder *b*, if the air can get under it, will be pressed down with some force by the atmosphere; but a weight or spring should be applied to the top of it, to make the pressure down equal to the upward pressure, that the working power (the cylinder *b*) may have an alternate motion of equal force applicable to the working of machinery. Or two engines may be made use of, one to act upon the top of the other by means of a lever; or, if placed so that the working power may move horizontally, one may act upon the other by means of a straight bar, as represented by Fig. 8. It may be seen that the cylinders *a* and *b*, above described, (see Fig. 1,) are similar to the machines represented in Nicholson's Treatise on the Science of Hydrostatics, to shew the upward pressure of fluids; and that the bag with boards at each end, described hereafter, is similar to the figure of the machine which Ferguson in his lectures on hydrostatics calls the Hydrostatic-bellows. The pipe, cylinder, or other vessel, being made to descend and ascend, is the invention which, by occasioning a body of liquid to flow in and out of the above-mentioned machines, renders them engines applicable to the purpose of working machinery by the liquid contained in the said engines without requiring a constant external supply. If it be requisite, the engine may be made with two or more pipes, cylinders, or other vessels, to ascend and descend. It may sometimes be found an advantage to have the working power acted upon by air instead of liquid, which may be managed in the way represented by Fig. 2. The pipe *c* being raised perpendicularly, the liquid runs from

it

it into the vessel *d*, the air from which passes through the channel *e* into the cylinder *a*, and forces up the working power *b*. It will be necessary to have a frame, containing a lever, fixed to the pipe *c o*, (see Fig. 1,) for the purpose of easily lowering and raising it, and also a weight to counteract the weight of the pipe when filling with water in its descent, which may be made similar to the following, so as nearly if not exactly to balance it.

Fig. 3, *a a*, may be made of wood, or any other material proper for the purpose, with a groove from one end to the other to receive the pipe *c o*, (see Fig. 1,) which may be fastened to it by a rope. *b*, is a lever, fixed to *a a*, and if the end *o* of the pipe *c o* be inserted in a box or chamber (as before described), the chamber may be made with a long arm, which may be fastened with screws to the lever *b*. *d*, a stay, to strengthen the frame. *e*, another stay, which may be a rope. *f f f*, a rope. *g*, a pulley. *h*, a pulley. *i*, a hook and ring. *k*, a vessel filled with water. *l*, a weight, which should be of rather more than the specific gravity of water, and of sufficient weight to balance the pipe *c o*, (see Fig. 1,) when horizontal and full of liquid. If the lever *b* be raised, the pipe *c o*, (see Fig. 1,) fastened to *d d*, will be lowered, and gradually filled with water, and its weight of course gradually increase; but it will be counteracted by the weight *l*, which is also an increasing weight, for as it rises the part out of the water becomes a weight in air, and consequently has more preponderancy than it had in water. The shape of the weight *l* will regulate the force necessary to counteract the increasing weight of the pipe *c o* (see Fig. 1) when filling with water in its descent, which will be clear by viewing Fig. 3, and considering that as the weight rises out of the water it increases in preponderancy more the second inch than the first, and

rise,

rises, so does the weight of the descending pipe *c o* the second inch it falls, than the first. The shape that may be requisite cannot here be stated, as it will depend upon the dimensions of the pipe *c o*. Another way of balancing the descending and increasing weight of *c o* in its ascent and descent is shewn by Fig. 4, where *a a* is represented in a horizontal position; *c o* is supposed to be fastened to it, and full of water. By inspecting the figure, it is evident that the pendulum *g* does not act at all upon the lever *b*, but the pendulum *f* does with all its weight. If the lever *b* be lowered towards *d*, the pendulum *f* will fall towards *g*, and the pendulum *g* will rise towards *d*, till the pendulums become in equilibrium, when the pipe *c o* will be sufficiently raised, the water having run from it. The ball *g* is intended to regulate the force which is necessary to act upon the lever *b*, which it will do as it shall be placed nearer or farther from the fulcrum; for which purpose, the bar to which it is attached may be made to pass through its centre, so that it may be fixed by a screw to any part of the bar. Another kind of balance for the weight of the pipe *c o* may be made by a wheel similar to the chain-wheel of a watch, with a rope and weight attached to it. This engine may be made in the following way: suppose a bag made of thick leather, or other material capable of holding liquid, kept open by hoops, at any convenient distance from each other, and closed at each end by boards, so as to prevent the escape of any liquid, except at an orifice to admit the water way *d*, (see Fig. 1,) just above the lower board; it will then open and close like a paper lantern, and may supply the place of the two cylinders *a* and *b*, described in Fig. 1, for the other parts of the engine being the same as described in Fig. 1, and the hollow joint *d* inserted in the orifice just above the lower board, if the

pipe

pipe *c c* be placed in a horizontal position, and filled with water, upon it being raised perpendicularly the water will run into the bag, and press up the upper board as it did the cylinder *b*, in Fig. 1. The pipe being again lowered to a horizontal position will occasion the water to quit the bag, and the upper board will be depressed.

Fig. 5. The vessel *z* having been raised, the water has run from it through the flexible pipe *y* into the cylinder *x*, and pressed up the inner cylinder *w*. Now if the lever *v* be pressed down, it will raise the pendulum *t*, which is a balance for the vessel *z*. *z* will be lowered, and filled with water from *x*, and the cylinder *w* will be depressed as the cylinder *b*, in Fig. 1, was described to be.

Fig. 6 shews the Figs. 1 and 4 united, the pipe being horizontal, ready for filling with water.

Fig. 7 represents a mode of producing a rotary motion by an alternate one, which may be made use of when a circular motion is required for the working of machinery by this engine; as the frame *a a* rises by the upward pressure of the cylinder *b*, the catches on the right hand side of the frame take the cogs on the right hand side of the wheel *c*, while the catches on the opposite side of the frame give way to the left hand cogs of the wheel *c*; when the frame falls with the cylinder *b* the reverse takes place with respect to the catches and cogs, by which double operation the wheel *c* is constantly pressed round the same way. At the back of the catches are springs to restore them to their situation after having given way to the cogs; and in the front of them are pins, to prevent their passing that way. If it be found that the catches do not take hold of the cogs sufficiently quick, another set of catches may be placed at the back of the frame *a a*, to take the cogs of another wheel fixed on the same axle-

tree

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Fig. 1.

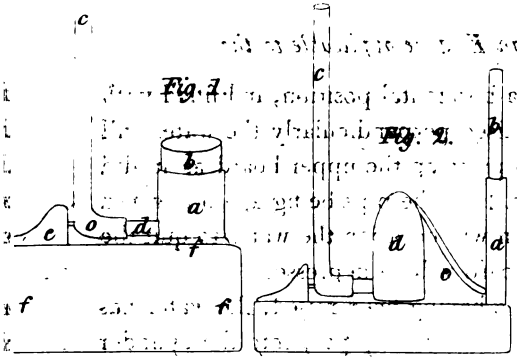


Fig. 2.

Fig. 7.

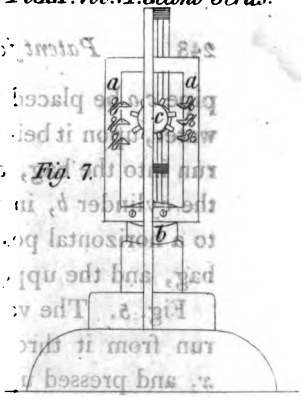


Fig. 3.

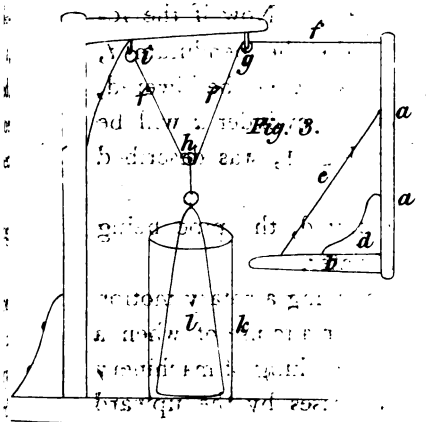


Fig. 4.

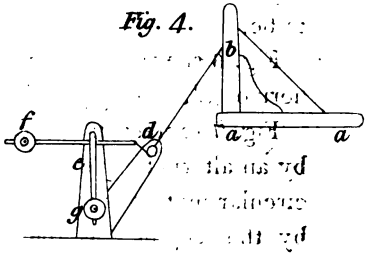


Fig. 5.

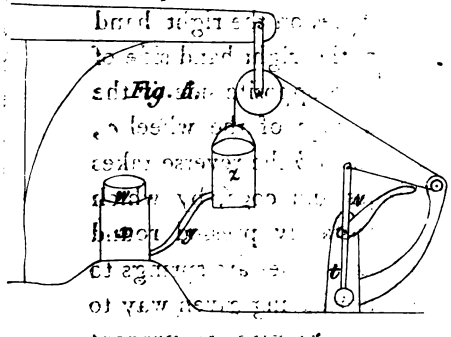


Fig. 8.

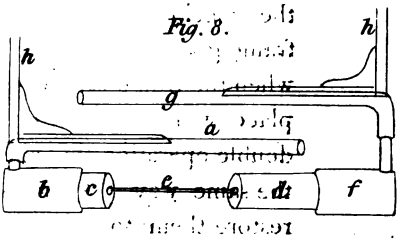
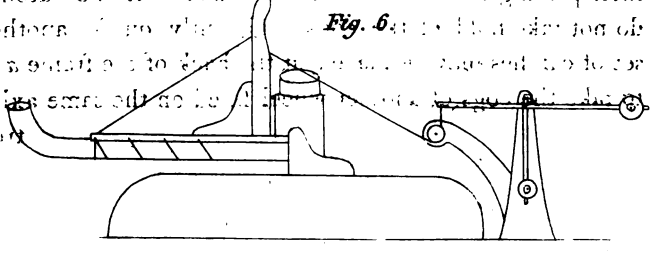


Fig. 6.



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tree in such a way that the cogs of one wheel may be opposite to the spaces of the other.

Fig. 8. This drawing represents two engines, the working powers acting upon each other horizontally. The two pipes *a* and *g* being filled with water, if the pipe *a* be raised perpendicularly the water will run into the cylinder *b*, and by its pressure upon the end of the cylinder *c* force it forward, when the cylinder *d*, being attached to *c* by the bar *e*, will be forced into the cylinder *f*; then if the pipe *g* be raised, and *a* lowered at the same time, the water will run into the cylinder *f* and out of the cylinder *b*, and the reverse will take place with respect to the cylinders *c* and *d*. The alternate motion of the bar *e* will be a force applicable to the working of machinery. The pipes *a* and *g* may be made to rise and fall alternately, by means of three cog wheels, one in the middle to work into the two others. The bars *h h* of the frames attached to the pipes *a* and *g*, being axletrees for the two outside wheels, suppose one of the pipes horizontal, the other perpendicular, then if the middle wheel be turned one quarter round, it will raise one pipe perpendicular, and lower the other to a horizontal position.

In witness whereof, &c.

OBSERVATIONS BY THE PATENTEE.

The weight of the pipe which is made to ascend and descend can be balanced, therefore the power necessary to raise and lower it is no more than what is sufficient to turn a balance. Since then the power necessary to produce the force is but little, while the force produced is very great, I am of opinion that the engine may be made to continue in action by its own energy, for I think a part of the force produced may be made to supply the producing power by means of the cog wheels.

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Specification of the Patent granted to ABRAHAM UNDERDOWN, *late of the Parish of Eling, in the County of Southampton, but now of Braynes-row, Spa-fields, in the County of Middlesex, Gentleman; for a new Mode or Method of making Flour without Grain.*

Dated December 19, 1804.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Abraham Underdown do hereby describe and ascertain the nature of my said invention, and in what manner the same is to be performed, as follows; that is to say: I take turnips, potatoes, parsnips, white-beet, and Jerusalem artichokes, and I grind or grate them fine; I then put the substance into water, and I let it remain therein several hours; I then strain off the water, and I add fresh water in quantity sufficient to cover the substance. Which process I continue to repeat until the water pours off quite clear. Then I strain and press the water from the vegetable substance, which I then dry on a kiln, or other proper convenience. When the substance is quite dry I grind it in a corn or other proper mill until it becomes fine flour. Either of the above vegetables alone, or any two or more of them mixed together, and prepared as before specified, will answer for the purpose. The foregoing description is for the making course or common flour: when I make fine or best flour I pare or peel the rind off the vegetables before I grind or grate them. I then pursue the same process as with the coarse or common flour.

In witness whereof, &c.

Specification

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Specification of the Patent granted to WILLIAM-HENRY CLAYFIELD, *of Bristol, Wine-merchant; for certain Processes for separating the Alkalis of Potash and of Soda from their Sulphates or Vitriolic Salts, and from their Sulphurets or Combination with Sulphur, as in Soapers Black-ash and other similar Compounds.*

Dated November 22, 1804.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said William-Henry Clayfield do hereby declare that my said invention is described in manner following; that is to say: In the first place I convert the sulphates or vitriolic salts into sulphurets or livers of sulphur by the common process, which is as follows. I introduce into a flat-bottomed reverberatory furnace, nearly resembling a lead furnace, or one of any other suitable construction, a quantity of sulphate of potash, sulphate of soda, or soapers black-ash, either severally and alone, or otherwise, by mixture of one or more of the said sulphates and black-ash, as may be most convenient or suitable to the intended purpose. And to the said substances, when in the furnace, I add a quantity of charcoal, wood, coal, peat, or other similar combustible matter, in small pieces, or coarse powder, and expose the mass to a red heat, to bring the salts into fusion. And I maintain and keep up the fusion, and frequently stir the mass, with the addition of more charcoal or inflammable matter, until the greater part of the sulphuric acid therein contained becomes converted into sulphur, and a large proportion of sulphuret is formed.

Having stated this process to be in common use, I cannot claim any exclusive privilege for the use of the same.

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The processes which are the object of my patent are as follow.

The sulphurets being formed from the salts described above, and the matter still in a state of fusion, I add a still farther quantity of charcoal, or other combustible matter, to convert the mass into a paste, and at the same time I add a quantity of lead, in its metallic state, litharge, or other oxyde or calx of lead. Which metal or oxyde unites with the sulphur of the compound, forms an artificial galena, or sulphuret of lead, and leaves the alkalis united with a portion of carbonic acid formed from the coal and other inflammable substances made use of.

It is essentially necessary to the success of this decomposition, that the mass should be kept at a very low red heat, frequently raked about, with the addition of a farther quantity of charcoal, or other combustible matter, and intermixed with the lead or oxyde as intimately as possible. (To check the fusion of the mass more effectually, and to facilitate the combination of the lead with the sulphur, I occasionally make use of damp charcoal towards the end of the operation; I do not, however, consider this variation in the process absolutely necessary.)

The compound mass must then be withdrawn from the furnace, and frequently sprinkled with a small quantity of water, broke up, and exposed to the action of the atmosphere for a week or ten days; after which time the alkalis, being nearly saturated with carbonic acid, may be separated along with such other salts as may be present by lixiviating the mass, and the sulphuret of lead will remain behind.

The neutral salts may be separated from the above by crystallization, after which the alkalis may be obtained by

by boiling down the solution; or the soda may be first separated by a farther crystallization.

The proportion of ingredients will depend on the substances made use of. In those cases where the sulphates of potash or of soda are used in a dry state, about two-thirds the weight of charcoal, and about five parts of lead to four of the sulphate, will be required to effect the decomposition; but where coopers black ash is made use of, a smaller quantity of the above materials will be sufficient.

Lastly, I employ zinc or its oxydes instead of lead or the oxydes of that metal, in the operations before described; but I give the preference to lead or its oxydes for their cheapness and facility of reduction.

In witness whereof, &c.

On the Treatment of Farm Horses.

By JOHN BANNISTER, *Esq.*

(Concluded from Page 186.)

FEW of the people whom I have now described, namely, those who break the bonds of every social tie to feed and pamper their favourite animals, will use the horses with cruelty, or neglect the management of them in the stable; but there are others of a different cast, who being by nature indolent, and of a morose and evil disposition, proceed to their work with disgust, and spend those hours, which should be appropriated to a necessary attendance on the horses, at the ale-house or the forge, or, in short, at any other place but where they are wanted. These often degenerate into the contrary extreme, and not only waste their master's property by neglecting his interest, but, careless of the welfare of the horses

horses with which they are entrusted, incapacitate them for business by their ill-usage and want of attention.

The possession of a fat team is likewise not unfrequently the master's pride; and when this happens to be the case, one can hardly blame the servant in any deception he may use to promote a sleek and comely appearance in his cattle, since by these arts he is likely to purchase his master's favour; and where a farmer is thus attached to the silly emulation of excelling his neighbours in this particular of a fat team, the allowance of corn, it may be presumed, is very ample, and the labour required from the horses by no means fatiguing.

The management of the plough-team varies essentially in different countries, and even in different parts of the same county; whether we consider the labour to be performed as a day's work by the same number of cattle, the quality and quantity of their food, or the stated hours for baiting and attendance. In the eastern part of Kent, the waggoner or head ploughman pays an early regard to his horses, and baits them continually with chaff and corn from the time of his rising at four o'clock till six or seven, when the day's work commences; and in the afternoon, whilst the mate is baiting, the waggoner employs himself by cutting cavin into chaff, or where this is not in sufficient plenty, hay and straw mixed, and sometimes oats in the sheaf. At eight in the evening he goes to bed, and leaves the attendance of the team to his mate, who sits with them till ten, so that the horses are left but a few hours to themselves; and this diligent attendance is unavoidably necessary, since in this country the horses are not permitted to have any rack-meat, but have generally a full allowance of corn; whereas, on the other side of the county, the stable door is rarely opened of a morning before five or six o'clock in the winter, and by nine

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nine in the evening the horses are racked up and left to their repose; and as by this method of giving the horses rack-meat, the less chaff is required, so there is generally a sufficient quantity of this produced by the thresher; if not, the labour of cutting does not often fall to the share of the ploughman, but is paid for by the farmer to a person who is expert at this business.

In support of the former practice may be urged the reserve of a considerable quantity of fodder, which, when given to the horses without limitation, forms a large item in the rural accounts at the end of the year, especially when the situation is within a small distance of London, or any place of considerable note where hay usually fetches a large price; to which may be added the advantage which the horses reap from the constant attendance that must necessarily be paid to them when baited in the manner before described, whereby the servants are kept continually in their work, and prevented from loitering away the afternoons at the ale-house or the smith's shop, as is too frequently the case with those who have more leisure on their hands; a great expense is likewise saved, which must otherwise be paid for cutting chaff. On the other hand, the farmer, who prefers the more general custom of allowing rack-meat to his horses, may enumerate the following advantages accruing from this method: First, the weekly allowance of corn may be more sparing, where the horses have constantly some kind of rack-meat to resort to, than when their whole dependence rests on the manger; nor is it necessary that such rack-meat be wholly confined to hay, but may consist partly of pea or bean straw, at those times when the labour of the horses is light; and in seed-time, or whenever the team is tasked with heavy work, though sainfoine, clover, &c. may be allowed them of a night, yet

this

this need not be given to an unlimited degree, which indeed would quickly end in the consumption of a large stack, but be trussed out in such proportion as the master may judge expedient, obliging the servants to tend the horses with chaff in the afternoon. Under these restrictions, the consumption of fodder may perhaps not exceed in value the sheaf-corn allowed to the teams in East Kent. A second consideration in favour of this practice is in having the ploughman at leisure in the afternoon to employ about occasional jobs, whilst in East Kent these domestics have a just excuse for refusing to lend a helping hand towards expediting any other work than what appertains solely to the management of their horses: and this advantage of having the servants at liberty to employ in the afternoon is of no inconsiderable moment, since by their efforts many jobs may be accomplished which would otherwise have demanded the aid of a labourer, the expenses of whose hire in the course of a winter will swell up to a large amount; not but there are many farmers who never employ their servants in an afternoon to any other work than what the care of the horses affords them; and this relaxation on the part of the master has given so great encouragement to the servants in their obstinacy, as to furnish a pretext for disobeying every order but what respects the horses, or the work to be done by them; a disposition which there seems no other means of correcting but through the medium of that necessary officer of justice, a civil magistrate, who never fails on application to back the master's intreaties with a threat of Bridewell, in case of the servant's obstinacy and refusal, a measure which generally secures their compliance.

To the two considerations last mentioned may be subjoined a third, which in the end may turn out of more

consequence

consequence that either of the former plans, or the opportunity enjoyed by the farmer who gives his horses each meal of seeing the stable door locked up at night and opened again in the morning, and this cannot be conveniently done where the ploughmen is to sit up late, and to rise the next morning at three or four o'clock, and thus an object of the most serious consideration is left to the care of fellows, who are rarely deserving of any trust; namely, the danger from fire, whereby the negligence of the servant may involve a family in total ruin, not to mention the great waste of candles in the many dark hours wherein the ploughman is necessarily engaged with his horses.

Such are the different modes of conducting the economy of a farmer's stable throughout the winter months; where, without the most vigilant caution on the part of the master, such waste will be committed as to render fruitless and abortive his most laborious exertions in the field.

Whichever of these methods shall be preferred, it is obvious that the maintenance of the horses in a condition to go through their winter's labour will be attended with no trifling expense; and therefore it should seem a matter of prudence to be furnished with green meat early in the spring, that the teams being turned into the field, or having a sufficient quantity of grass mown for them, the expense of corn may in a great measure be saved; for so highly nutritious are the juices of green food of every kind, and so agreeable is this provender to the taste of these animals, they will go through more severe labour, carry a smoother coat, and thrive abundantly faster on this meat alone than with a full allowance of hay and corn; so that there are many farmers who never give their horses corn during the summer months, whilst

others take off half their winter's allowance. This is a great saving, besides the advantage of employing the ploughmen in the latter part of the day at various kinds of business, which, as the spring advances, becomes necessary to be expedited.

The most general food for working-horses in the first part of the summer, when not turned to grass, is that arising from the tare. This succulent herbage is raised from the small seed called winter tare, which ought to be sown with all convenient dispatch after harvest, on a piece of ground in good condition, and at no great distance from the yard: much depends on the nature of the soil and the state of the weather during the winter and spring months, as to the season when these pulse will produce a crop fit for the scythe; but if the weather has not been very unkindly, they may be expected to turn out a tolerable good swarth at the beginning of old May, and when this first provision shall be expended, the clover and sping tares will come in, so as to afford the horses a constant succession of green meat during the summer. And this method of feeding them with green meat in the stable or in the yard, (for there are many people who contend in behalf of the superior advantage in the point of health, when the horses are turned into the yard of a night, and there fed from the crib, over the mode of keeping them continually in the stable,) the practice, I say, of confining them to their meat is far preferable to that of turning the horses into a meadow when their day's work is finished, and this on many accounts; First, by having their meat cut for them, they avoid the continual plague of those tormenting insects, flies, which are a perpetual source of complaint to cattle of every kind when feeding abroad in the summer months. Secondly, by thus feeding and reposing themselves

selves at home, the mischief likely to accrue from the horses breaking out of their pastures is obviated: whereas when they are turned into the uplands, although the grass be never so good, the gates well secured, and the fences strong; yet so tempting is the verdure of every field at this season of the year, and the horse an animal so prone to ramble, that the danger of their quitting the pasture allotted them during the night is very great; and in such case a team of horses may create more mischief in six hours than 20*l.* or perhaps 50*l.* will repay, besides the plague of seeking them in the morning, the greatest part of which may haply be consumed in a fruitless enquiry, and half the day be gone past ere the teams are harnessed for their work. Thirdly, the waste which is made either in a piece of grass or clover where the horses are suffered to ramble over the whole close *ad libitum*; it being a clear case, that the produce of one acre of green meat given in the rack will maintain the same number of horses much longer than three acres would have done if they had been suffered to go over the field at their pleasure. Add to these another consideration, which to a farmer is a matter of the utmost importance; and this is, the waste of the dung and urine, since it is universally allowed, that the soil of the horse dropped casually in various parts of the field is of little or no use, the virtues of it being exhausted by the heat of the sun, and the surface of the ground prevented by this covering from putting forth a fresh shoot of grass; whereas when the team is fed with green meat in the stable, with a plentiful allowance of litter, the dunghill will be considerably raised during the summer; for this food, being very succulent, acts with the animal as a powerful diuretic, by which means the straw is quickly converted into manure, and becomes a valuable addition

to the repository of a farm-yard. I know but of one argument which the advocates for grazing their horses abroad can bring in favour of this practice; namely, the keeping the animals in health by action, to which they are naturally inclined, and thus preventing the accidents of swelled heels, &c. But this advantage is by no means precluded, when the mode of feeding the team with green meat in cribs is pursued, as hath been touched upon before; and here they may have the free enjoyment of their limbs, without any of those hazards so likely to ensue from their feeding abroad; though when a horse is kept with proper strictness to his work, I believe there will be little danger of his becoming greasy by standing in the stable at night, except in some particular constitutions.

Though tares are a very wholesome diet in the first part of the summer, they should be cautiously given, or rather wholly discontinued as the summer advances, and they are become rotten on the ground. At this time I am convinced they are a food highly improper for the horses, and when given in that state frequently turn out very prejudicial to their health; for this vegetable, from its extreme succulency, contributes to fill their bodies with ill humours, whence originate disorders of various kinds, such as yellows, staggers, farcy, and other fatal or incurable maladies. On this subject I can speak with the greater confidence, as the major part of my own team fell a sacrifice to this imprudent conduct in the year 1773. In this summer several of my working horses were carried off by the staggers, occasioned, as I am well persuaded, by their feeding in the month of June on summer tares, which were remarkably grass, and by being lodged had become rotten on the ground. To avoid this pernicious consequence, it seems the best method to discontinue

in the use of oats as soon as the change takes place for the scythe, and where there remains no other alternative, rather to turn the team abroad, than to endanger their health by suffering them to feed on such foul and unwholesome diet.

But to guard effectually against every obstacle, the most prudent way is to raise a field of lucerne in the vicinity of the yard, which will afford a plentiful supply of wholesome and nutritious aliment till the time approaches for taking the horses up to dry meat. The first cutting of this excellent vegetable, if properly managed, may commence a fortnight or three weeks before the tares will be ready for the scythe, and the mowing may be continued throughout the summer without any danger to the cattle, and to the infinite emolument of the farmer, who will thus possess an opportunity of furnishing his horses with a wholesome food, and that in great abundance, and at a trifling expense, till the return of winter renders it necessary to discontinue the green meat, and the tares and clovers may be reserved for the other various purposes to which they are capable of being applied.

It is a very salutary practice to bleed the team previous to turning the horses to grass in the spring, and to repeat it when they are taken up to dry meat at the autumn, though there are many people who object to these periodical evacuations, alledging that the constitution of the animal is rather injured than otherwise by this habit. But when it is recollected that the horse is subject to a greater variety of disorders than any other quadruped, and from his constant labour is particularly liable to have his blood and juices contaminated, it must be evident that this disposition is likely to be increased by a change of diet, particularly on a sudden transition from dry fodder to green meat, where from the superabundant succulency

lency of the food, the humours, which at this season of the year are in continual flux and agitation, will be accelerated to that degree as to bring on disorders which may terminate in the death of the creature, and which might not in all probability have taken place, if a copious discharge of blood had been promoted some few days before the winter provender had been discontinued; nor is the autumnal bleeding less necessary to carry off any foul humours which the succulency of the grass may have occasioned, and to preserve the health of the team during the winter; and if to this bleeding a dose or two of physic were to be added, it would be a still farther means of insuring the health of the horses, and rendering the farrier's attendance unnecessary.

The proper time for taking the horses from grass is about Michaelmas; for, though we have often warm sunny weather till the latter end of October, yet the grass by that time will have lost much of its sweetness, and become less nutritious.

One acre of whole ground is accounted a good day's work for a plough and four horses, if the soil is of a middling texture; but in stirring fallows, when the days are long, and the land pulverized by the former tillage, on very light soils, an acre and a half may, with great facility, be ploughed in a day by a four-horse team.

On stiff lands it will be necessary to unite an additional pair of horses to the team, and this renders the expense in tillage on these grounds much more considerable than on the lighter soils; but this increase of charge will be amply compensated by the future crop, which never fails to be more abundant and productive than what is raised on the thin grounds.

The term for the mares going with foal is eleven months, with the addition of a day to every year of the animal's

animal's age. The mare which is intended to supply the team with draught colts should be large-limbed, close-jointed, short-necked, wide-chested, home-ribbed, with a capacious body; her eyes should be clear, full, and pellucid, and her nostrils large and open; in disposition she ought to be gentle and tractable, of a constitution healthy and vigorous, free from any blemishes, either hereditary or acquired. The horse should be bold and spirited, well made, and of a kindly disposition; his constitution should be strong, his temper good, and, in short, neither in mind or body, ought he to be contaminated with vices or disease of any kind, since on the good qualities and strength of constitution in the sire and the dam depends in a great measure the future welfare of the colt. The proper time for putting the mare to horse is in the months of May or June, according to the fertility of the soil, always observing that an early colt is to be preferred to one which falls later in the season.

During the time of gestation, the mare may work in the team as usual, till within a fortnight of the time when she is expected to foal; but it is necessary that her labour as she advances in her pregnancy should be gradually slackened, lest any hurt should accrue to the foal or the dam by hard exertions in the harness, which might probably occasion the mare to slink her foal, or perhaps might be productive of still more dangerous consequences. The mare, within ten days or a fortnight of the time when she is expected to foal, should be turned into an orchard or other warm inclosure, where she may rest secure from the interruption of other horses, and be free from any annoyances likely to occasion disturbance to her at this time, and after foaling should be allowed to run

with her colt in the same pasture for a month longer, if not particularly required in the mean time. The field set apart for the dam and eight should be free from declivities or precipices of any kind, and the grass should be of a length to afford a good bite, and to furnish sufficient nourishment to the mare for a copious supply of milk.

During the time that the colt runs with the dam it ought never to be allowed to suck, while the mare is warm from the consequence of her labour, as the milk at that time would be highly prejudicial to the young creature.

The proper time for removing the colt from the dam is about Michaelmas; and at this time care should be taken to keep the mare and foal from the hearing of each other, that neither the mare may bewail the loss of her colt, nor the latter fret and pine after its mother. The best method will be to confine the foal in a small stable by himself, which should be furnished with a rack and manger, where he may be fed with well-shaken hay and clean-sifted oats, bruised a little in a mill. With this management he will quickly forget his dam, and become gentle and familiarized to his keeper, and in fair weather may be suffered to exercise himself in a pasture adjoining to the stable; but this should be only for a little while in the middle part of a sunny day, the tenderness of the young animal rendering it necessary that he should be kept under cover during the winter.

Having been thus properly managed in the first winter, he will by the following spring have made rapid advances in growth, and as the warm weather comes on may be suffered to range throughout the day in his pasture, and at night be lodged in the stable, and when on

the approach of summer it will be no longer necessary to bring him into the house, he may continue in the pasture as well during the night season as in the day.

The proper age for gelding the colts is at ten days or a fortnight old, or as soon as the stones are come down, and the most proper season is the months of April or May, and if not done at that time it ought to be deferred till the end of September. Although it be safest to cut the foal at the age above mentioned, yet the operation may be performed without hazard at two years old.

The like care in respect to housing the colt is required in the second winter, as was directed in the first, only that now he may be led by the halter to the pond, be frequently curried, and accustomed to such other acts of familiarity which have a tendency towards rendering him tractable and obedient, so that at the return of summer his harness may be put on, and he may be employed in some kind of gentle draught work in company with other horses; but this exercise should at first be very light and easy, and not protracted too long, so that the young horse may seem rather pleased than disgusted with his new employment. He should often go short journies in the team upon the road, that his sight may be early inured to different objects, which will dispose him to be more tractable and less addicted to fear than he would have been if this precaution were neglected. By this management, and by alternate easy days work at plough and in the waggon, the young horse at the end of the summer will become able to perform nearly an equal share of labour with the rest of the team, and having been fed and managed in the like manner with the other horses, may, at the approach of winter, be taken into the stable with them.

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The docking of colts may be performed when they are a twelvemonth old, either in the spring or autumn, but it ought never to be done in the summer months.

Those people who have great store of waste pasture, such as heaths, moors, &c. possess the fairest opportunity of breeding colts, which are here reared at a trifling expense, and having plenty of room to sport and range at pleasure, with good and wholesome water, do grow out to their full size, and become more serviceable for the team than those which, from a more confined situation, have not enjoyed these advantages.

Analytical Experiments and Observations on Lac.

By CHARLES HATCHETT, *Esq. F. R. S.*

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY.

THE period is uncertain when the substance called lac, so curious in its origin and so useful to many arts, was first introduced into Europe; and, although it probably was known to the ancients, yet the inaccuracy of their descriptions precludes this from being stated as a positive fact.

The natives of India have long employed it for various purposes, exclusive of those which cause it to be in request with Europeans; but many of the Indian processes are undoubtedly as yet unknown to us.

One of these, of a very useful nature, was some time since obligingly communicated to me by Charles Wilkins, Esq. F. R. S. and has been the cause of this inquiry into the nature and properties of lac.

Mr. Wilkins informed me, that the Hindûs dissolve shell lac in water, by the mere addition of a little borax; and

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and the solution, being then mixed with ivory-black, or lamp-black, is employed by them as an ink, which when dry is not easily acted upon by damp or water. Upon trial I found the fact to be exactly as Mr. Wilkins had stated, and therefore made other experiments; but the results of these I shall at present omit, as they will occur with more propriety and perspicuity in the latter part of this paper.

In respect to the natural history of lac, we are much indebted to Mr. Kerr *, Mr. Saunders †, and Dr. Roxburgh ‡; from whose valuable communications to this Society, we learn many curious particulars concerning the formation of this substance, which, from their accounts, and from inspection, evidently appears to be the nidus or comb of the insect called coccus or chermes lacca, deposited on branches of certain species of mimosa and other plants.

Lac is distinguished into four kinds; of which, however, only three are commonly known in commerce, *viz.* stick lac, seed lac, and shell lac; the difference of these, with that of the fourth, called lump lac, is as follows.

1. Stick lac is the substance or comb in its natural state, incrusting small branches or twigs.

2. Seed lac is said to be only the above, which has been separated from the twigs, and reduced into small fragments; but I suspect it to have undergone some other

* Natural History of the Insect which produces the Gum Lacca. By Mr. James Kerr, of Patna. Phil. Trans. for 1781, p. 374.

† Some Account of the vegetable and mineral Productions of Boutan and Thibet. By Mr. Robert Saunders. Phil. Trans. for 1789, p. 107.

‡ *Chermes Lacca.* By William Roxburgh, M.D. Phil. Trans. for 1791, p. 208.

process, as I have found the best specimens to be very considerably deprived of the colouring matter.

3. Lump lacs formed from seed lac, liquefied by fire, and formed into cakes. And,

4. Shell lac, according to Mr. Kerr and Mr. Saunders, is prepared from the cells, liquefied, strained, and formed into thin transparent laminæ, in the following manner.

"Separate the cells from the branches; break them "into small pieces; throw them into a tub of water, for "one day; wash off the red water; dry the cells, and with "them fill a cylindrical tube of cotton cloth, two feet "long, and one or two inches in diameter; tie both "ends, and turn the bag above a charcoal fire; as the "lac liquefies, twist the bag, and, when a sufficient "quantity has transuded the pores of the cloth, lay it "upon a smooth junk of the plantain tree, and with a "strip of the plaintain leaf draw it into a thin lamella; "take it off while flexible, for in a minute it will be hard "and brittle †."

The degree of pressure on the plantain tree regulates (according to Mr. Saunders) the thickness of the shell; and the quality of the bag determines its fineness and transparency.

Assam furnishes the greatest quantity of the whole of the lac now in use ‡.

* Mr. Robinson informs me that the crude lac, as it is taken from the branches and twigs of the trees, is usually deprived of its colouring matter by boiling, having been previously reduced by pounding into small fragments. In Bengal, the silk dyers are the people who thus produce what we call the seed lac, which they do for the sake of the colour.

† Phil. Trans. 1781, p. 379.

‡ Phil. Trans. 1789, p. 109.

Mr.

Mr. Kerr (speaking of stick lac) observes, that the best lac is of a deep red colour; for, if it is pale and pierced at the top, the value is diminished, because the insects have left their cells, and consequently those cannot be of no use as a dye or colour, but probably may be better for varnishes.

The seed lac which I have examined contained but little of the colouring matter, and appeared (as I have already observed) to have undergone some process of purification; but, of all the varieties, shell lac contains the least of the tinging substance, as may well be expected, when the mode of preparing it is considered.

It is remarkable, that although lac has been known, and imported into Europe, during so long a time that the date cannot now be ascertained, yet it has but little attracted the attention of chemists.

The first chemist of eminence who mentions it, and the only one who has subjected it to any thing like a regular examination, is the younger Geoffroy, whose paper is published in the *Mém de l'Acad. de Paris* for the year 1714*. In this paper Mr. Geoffroy seems to have been chiefly induced to examine it on account of its tinging substance; but he nevertheless has not neglected the substance which constitutes the cells. This he considers to be a sort of wax, very distinct from the nature of gum or resin. But it is to be observed, that he formed this opinion, not so much upon the results of chemical experiments, as upon the cellular construction observed in the stick lac, which, as he justly remarks, demonstrates it to be formed by insects, after the manner that the honeycomb is formed by bees; and that it is not there-

* Observations sur la Gomme Lacque, et sur les autres Matières animales qui fournissent la Teinture de Pourpre. Par M. Geoffroy le jeune. *Mém. de l'Acad.* 1714, p. 121.

fore,

fore, as some have supposed, a gum or resin, which has exuded from vegetables simply punctured by insects *.

Geoffroy and Lemery obtained from lac, by distillation, some acid liquor, and a butyraceous substance. Moreover, Geoffroy observes, that, when stick lac was thus treated, some ammonia was also obtained, but not when seed lac was employed.

He also mentions another sort of lac, brought from Madagascar, and called by the natives *Lit-in-bitsa*. This substance, he says, is scarcely to be distinguished from bees-wax, which it much resembles in colour and odour; and that it is produced by a grayish insect, much larger than the chermes lacca. It is evident however, from Geoffroy's description, that this substance is very different from the common lac; and there can be little doubt, but that it is the same as that which was, a few years ago, examined by Dr. Pearson, under the name of white lac, a substance resembling the Pé-la of the Chinese †.

Geoffroy (as I have stated) considered lac as a sort of wax; and since his time it has scarcely, if at all, been subjected to chemical examination; it is not therefore suprising, that the opinions of chemists concerning it have been various. Chaptal adopts the opinion of Geoffroy, and calls it a kind of wax ‡; but Gren § and Fourcroy ‖ regard it as a true resin.

* Mr. Kerr observes, that as a red substance is obtained by incision from the plaso tree, very analogous to lac, it is probable that the insects have little trouble in animalizing the sap of these trees in the formation of their cells. Phil. Trans. 1781, p. 377.

† Phil. Trans. 1794, p. 383.

‡ Chaptal's Elements; English edition, vol. III. p. 387.

§ Principles of modern Chemistry, vol. I. p. 388.

‖ *Systéme des Connoissances chimiques.* Tome V. p. 264.

§ I.

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§ I. *Effects of different Menstrua on the Varieties of Lac.*

1. When water is poured on stick lac, which has been separated from the vegetable branches, and reduced to a coarse powder, it immediately begins to be tinged with red; and, with the assistance of heat, a deep-coloured crimson solution is formed.

Repeated operations of this kind reduce stick lack to a yellowish-brown substance; and the water no longer receives any colour.

The portion thus separated from stick lac has, upon an average, amounted in my experiments to about 10 *per cent.* but this is not to be regarded as the total quantity, for a part is obstinately retained by the resin and other ingredients, so that it cannot be completely separated; and, moreover, very considerable variations must be expected in different samples.

Fine seed lac did not afford more than 2½ or 3 *per cent.* of the colouring substance; and shell lac, when treated in the same manner, (*i. e.* merely with water,) did not yield more than ½ *per cent.*

2. Alcohol dissolves a considerable portion of each of the different kinds of lac; and, when heat is not employed, the dissolved part is resin, combined with some of the colouring matter; but, if the lac is digested with heated alcohol, then the solution is more or less turbid, in consequence of some of the other ingredients becoming mixed and suspended; so that it is afterwards extremely difficult to obtain it in a state of purity and transparency, either by repose or by filtration.

The resin may be obtained by immediately subjecting the solution to evaporation or distillation, or by previously pouring it into water with which a small quantity of muriatic or acetic acid has been mixed; for thus, when the

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the whole is heated, a curdy precipitate of resin is formed, and may be separated by a filter, after which the liquor may be evaporated, in order to obtain any resin, or other substance, which may remain in solution after the first operation.

The solution formed by digesting stick lac in alcohol, without heat, is of a dark brownish-red colour, and the insoluble part subsides in the state of a dark-coloured magma; this retains the greater part of the colouring matter, which, as I have already observed, is most easily soluble in water.

The proportion of resin thus dissolved, when stick lac is treated with alcohol, has, in my experiments, amounted to 67 or 68 *per cent.* but this must depend on the quality of the samples.

The seed lac which I examined was very pure, and yielded to alcohol about 88 *per cent.* of resin: it contained but little of the colouring matter; and the other substances subsided, and formed a cloud at the bottom of the glass vessel.

Shell lac in small fragments, by simple digestion with alcohol, afforded in the first instance nearly 81 *per cent.* Part of the resin, however, still remained mixed with the residuum, and could not be separated but by subsequent operations: this part amounted to about 10; so that the total quantity of resin, in the shell lac which I employed, may be estimated at 91 *per cent.*

When the shell lac was only reduced into small fragments, these (after the separation of the first portion of resin) retained their figure, but were become more bulky, very elastic, and nearly white. I at first, therefore, suspected, that some caoutchouc was present in lac; but, finding that boiling water destroyed this elasticity, I was induced to make subsequent experiments, by which I discovered,

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discovered, that the elasticity of this residuum was principally owing to a substance which appeared to possess the properties of vegetable gluten. This, however, I shall more fully notice in another part of the paper.

The resin obtained from the varieties of lac is brownish yellow, and is not so brittle as the generality of other resinous substances.

3. Sulphuric ether does not seem to act so powerfully upon the varieties of lac as alcohol; for, as a great part of the resin is protected by the colouring matter, and by the other ingredients which are insoluble in ether, it naturally follows, that less of it can be separated by this liquor than by alcohol.

The different kinds of lac which have been digested in ether are considerably softened, although in other respects very little alteration is produced. Ether, therefore, is not the best menstruum for lac; but, under certain circumstances, it may be occasionally employed with advantage, for the purpose of analysis.

4. Concentrated sulphuric acid acts in the first instance on the colouring matter of lac; but, after a short digestion in a sand bath, the whole is converted into a reddish-brown thick liquor, which soon becomes black; and the chief part of the lac is separated in an insoluble state, resembling coal.

During the solution of lac in sulphuric acid a considerable quantity of sulphureous acid gas is evolved.

5. When lac is digested with nitric acid, nitrous gas is at first produced; the lac swells much, and is converted into a deep yellow opaque brittle substance, which, by a sufficiency of nitric acid, and continuation of the digestion during about forty-eight hours, is dissolved.

The solution however is turbid, and, when poured into a large quantity of distilled water, deposits some yel-

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lowish floeculi, which, being collected, are found to be a sort of wax.

The filtrated liquor is of a bright golden yellow; and, when saturated by ammonia, changes to orange colour, but does not yield any precipitate, nor any traces of oxalic or malic acid.

This yellow nitric solution is converted, by evaporation, into a deep yellow substance, which burns like resin, but is soluble in boiling water.

The alkalis and lime, being added to this aqueous solution, do not produce any precipitate, but the yellow colour is very considerably deepened; and by evaporation an orange-coloured substance is obtained, which is still easily soluble in water, and consists of the deep yellow substance above mentioned, combined with the alkali or lime.

6. Muriatic acid dissolves the colouring matter and gluten of lac; but its action on these is feeble, unless the resin has been previously separated.

7. Acetous acid, in its effects, much resembles muriatic acid.

8. Stick lac, seed lac, and shell lac, are partially dissolved by acetic acid; and, if this be heated, a considerable portion is taken up.

The dissolved part consists of the colouring extract, of resin, and of gluten; the wax being the only ingredient which is insoluble in this menstruum; but a portion of the former substances, being enveloped by the wax, are protected from the action of the acetic acid.

The acetic solution of lac becomes turbid when cold, and deposits part of the resin; a portion however remains in solution, and may be precipitated by water; after which, the liquor retains some gluten and colouring extract,

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tract, which may be precipitated by saturating the acid with an alkali, and by subsequent boiling.

For the reasons above stated, it would be difficult to effect a complete solution of lac by means of acetic acid; but this may nevertheless be advantageously employed in analytical operations, when alternately used with alcohol.

9. A saturated solution of boracic acid in water dissolves the colouring extract; but, as the effect does not surpass that of water alone, we may conclude that lac is little, if at all, acted upon by boracic acid.

10. It has been already stated, that sub-borate of soda or borax has a powerful effect on lac, so as to render it soluble in water; and, as the preceding experiments prove that boracic acid alone scarcely acts upon lac, there is every reason to believe, that the excess of soda present in borax is the active substance; and this conclusion will be confirmed by the results of subsequent experiments made with the alkalis.

In order to render lac (especially shell lac) soluble in water, about $\frac{1}{5}$ of borax is necessary; and this may be previously dissolved in the water, or may be mixed and added together with the lac.

The best proportion of water to that of lac is 18 or 20 to 1. So that 20 grs. of borax, and four ounces of water, are, upon an average, requisite to dissolve 100 grs. of shell lac; but more water may be occasionally added, to supply the loss caused by evaporation during the digestion, which should be made nearly in a boiling heat.

This solution of shell lac is turbid, and of a reddish-brown colour; when considerably diluted with water, and agitated, a weak lather is formed; it is decomposed by acids, and the lac is precipitated in yellow flocculi, which do not apparently differ from the lac originally employed.

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The general properties of the solution show that it is a saponaceous compound, which, being used as a varnish or vehicle for colours, becomes (when dry) difficultly soluble in water, although this was the liquid employed to form the solution.

A white thick scum or cream collects on the surface of this liquid, after it has been suffered to remain tranquil for some time, and is found to be produced by a sort of wax, which I shall more particularly notice when the analyses of the varieties of lac are described: but, in the present case, this wax appeared in some degree to be converted into an almost insoluble soap by the alkali of the borax, and may be regarded as the principal cause of the turbidness of the solution.

11. The lixivia of pure soda and of carbonate of soda completely dissolve the different kinds of lac; and these solutions exactly resemble those formed by means of borax, excepting that they are deeper coloured.

Rather less than $\frac{1}{5}$ of carbonate of soda is required to dissolve shell lac; and this solution, when dried, is sooner affected by damp or water than the solution prepared by borax.

12. Lixivium of pure or caustic potash speedily dissolves the varieties of lac, and forms saponaceous solutions, similar to that in which borax was employed, exclusive of the colour, which is deeper, and more approaching to purple.

Lixivium of carbonate of potash extracts a great part of the colouring matter, but does not form so complete a solution of the entire substance of lac, as when pure potash is employed.

The above alkaline solutions, by repose, afford the waxen soap which has been mentioned; and acids, being added to these solutions, and to that formed by borax,

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borax, precipitate the lac in a flocculent state, and of a yellow or buff colour; which precipitate, when melted, becomes similar to the lac originally employed. If, however, an alkaline solution of shell lac (prepared, for instance, with soda) be gradually dropped into a sufficient quantity of muriatic acid diluted with an equal portion of water, and nearly heated to the boiling point, and if after boiling the whole for about one hour the coagulum be separated, and the clear liquor be carefully saturated with soda, and again made to boil, a small quantity of a flocculent precipitate is obtained, which was found to be analogous to precipitated vegetable gluten, combined with some of the colouring extract.

13. Pure ammonia, and carbonate of ammonia, readily act upon the colouring matter of lac, but do not completely dissolve the entire substance.

TO BE CONCLUDED IN OUR NEXT.

Observations on Basalt, and on the Transition from the vitreous to the stony Texture, which occurs in the gradual Refrigeration of melted Basalt; with some Geological Remarks. In a Letter from GREGORY WATT, *Esq. to the Right Honourable* CHARLES GREVILLE, *V. P. R. S.*

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY.

THE important geological consequences that seem deducible from the changes of texture developed by Sir James Hall's very judicious experiments on the regulated cooling of melted basalt, induced me to attempt a repetition of them, some time after the publication of his interesting

interesting and ingenious Paper *. I believe that formerly I had the honour of showing you some of the results of my imperfect and diminutive experiments, which only served to afford additional proofs of the transition from the vitreous to the stony texture, which takes place in the gradual refrigeration of glass. Circumstances have prevented my resuming these investigations, till it lately occurred to me that something might be learned, by exposing to the action of heat a much larger mass of basaltic matter than, as far as I am informed, had ever at one time been subjected to experiment.

One of the common reverberatory furnaces used in iron founderies for the fusion of pig iron, was strongly heated by a fire maintained for several hours. About seven hundred weight of amorphous basalt, here called Rowley Rag, was broken into small pieces, and deposited gradually on the elevated part of the interior of the furnace, between the fire and the chimney, from whence, as it melted, it flowed into the deeper part, in which, in ordinary operations, the melted iron is collected. It was observed by the persons attending, that it did not require half the quantity of fuel, to fuse the basalt, that would have been necessary to melt an equal weight of pig iron. When the whole was melted, it formed a liquid glass, rather tenacious, from which a large ladle-full was taken, which, on being allowed to cool, retained the characters of perfect glass. The fire was maintained, though with gradual diminution, for more than six hours; after which time, the draught of the chimney was intercepted, the surface of the glass was covered with heated sand, and

* Published in the Transactions of the Royal Society of Edinburgh, Vol. V.

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the furnace was filled with coals, which were consumed very slowly. It was eight days before the mass in the furnace was sufficiently cool to be extracted, and even then it retained considerable internal heat.

The form of the mass, being given by the bottom of the furnace, was considerably irregular, approaching to the shape of a wedge whose lower angles were rounded. It was nearly three feet and a half long, two feet and a half wide, about four inches thick at one end, and above eighteen inches at the other. From this diversity of thickness, and from the unequal action of the heat of the furnace, too great an irregularity had prevailed in the refrigeration of the glass, to permit its attainment of a homogeneous texture. These circumstances might probably have been counteracted by better devised precautions; but the inequality of the product is not to be regretted, since it has fortuitously disclosed some very singular peculiarities, in the arrangement of bodies passing from a vitreous to a stony state, which might have remained unobserved, if the desired homogeneity of the result had been obtained. I shall now endeavour to describe the various products of this operation; and I shall also submit to your consideration, some remarks which appear to me to arise naturally from the phenomena I have observed; premising that, except where my opinions are supported by the unequivocal demonstration of facts, I offer them with the utmost deference to the decision of more experienced and judicious mineralogists and geologists.

It may be proper to give a concise description of Rowley rag itself, before I consider the products which it yields by igneous fusion. This species of basalt is fine-grained, of a confused crystallized texture; its fracture uneven in small pieces, conchoidal in large pieces. Its hardness

hardness superior to common glass, but inferior to feldspar. Its tenacity considerable. Its action on the magnetic needle strong, but without signs of polarity. Its specific gravity, according to my trials, 2.868. Its general colour iron gray, approaching to black. It is opaque; and it reflects light from a number of brilliant points, some of which seem to be feldspar, and others hornblende *.

1st. This substance is easily fused into glass, whose texture is completely vitreous, with few air-bubbles. Its fracture undulated conchoidal. Its hardness superior to feldspar, but inferior to quartz. It possesses scarcely any action on the magnetic needle. Its colour is black: it is nearly opaque, being translucent only in very thin fragments. Its specific gravity appears to be 2.743.

2d. The tendency towards arrangement, in the particles of the fluid glass, is first developed by the forma-

* "The ragstone has been accurately analysed by Dr. Withering, "who found that 1000 parts of it contained 475 parts of siliceous "earth, 325 argillaceous earth, and 200 calx of iron; but this iron "seems to me to be in a very small degree of calcination, from the "dark blue colour of the stone, from the rusty colour it assumes on "being exposed to a farther state of calcination by air and water, and "from the magnetic property of the mountains, which, as Dr. Plot "observed, turned the needle 6° from its proper direction. This mag"netic property has since been observed in several basaltic mountains, "particularly in the Giant's Causeway in Ireland, and very remark"ably in a basaltic columnar mountain called Compass Hill, in the "island Cannay, one of the Hebrides, described by George Demp"ster, Esq. in the Transactions of the Society of Antiquaries in "Scotland, Vol. I." See Mineralogy of the South-west part of Staffordshire, by James Keir, Esq. F. R. S. published in Shaw's History of Staffordshire, Vol. I.

Mr. Kirwan states the specific gravity of Rowley rag, which he calls *ferrilite*, at 2.748; and assigns its melting point at 98° of Wedgwood's pyrometer.

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tion of minute globules, which are generally nearly spherical, but sometimes elongated, and which are thickly disseminated through the mass. The colour of these globules is considerably lighter than that of the glass; they are commonly grayish-brown, sometimes inclining to chocolate brown, and, when they have been formed near the interior surface of the cavities in the glass, they project, and resemble a cluster of small seeds. Their diameter rarely exceeds a line, and seldom attains that size, as, in general, they are so near to one another, that their surfaces touch before they can acquire considerable magnitude. In the process of cooling, they adapt their form to their confined situation, fill up every interstice, and finally present a homogeneous body, wholly unlike glass, and equally unlike the parent basalt. When the union of the little globules has been imperfectly effected, the fracture of the mass indicates its structure, by numerous minute conchoidal fractures, which display the form of each globule. But, if the arrangement has extended a little farther, all these subdivisions are entirely lost; the mass becomes perfectly compact, has an even or a flat conchoidal fracture, is nearly of the same hardness as the glass, is commonly of a chocolate colour, graduating into a brownish-black, and the intensity of the colour increases in proportion to the degree to which the arrangement has extended. Its aspect is rather greasy; and it much resembles some varieties of jasper, in the compactness of its texture, and in its opacity. Its magnetic action is extremely feeble. Its specific gravity appears to be 2.938.

3d. If the mass were now rapidly cooled, it is obvious that the result would be the substance I have just described; but, if the temperature adapted to the farther arrangement of its particles be continued, another

change is immediately commenced, by the progress of which it acquires a more stony texture, much greater tenacity, and its colour deepens as these changes advance, till it becomes absolutely black. Sometimes this alteration is effected by a gradual transition, the limits of which cannot be assigned, but more generally by the formation of secondary spheroids, in the heart of the compact jaspideous substance. These spheroids differ essentially from those first described; the centres of their formation are more remote from each other, and their magnitude is proportionably greater, sometimes extending to a diameter of two inches, and seeming only to be limited by contact with the peripheries of other spheroids. They are radiated, with distinct fibres; sometimes the fibres resemble those of brown hæmatites, and sometimes they are fasciculated irregularly, so as to be very similar in appearance to the argillaceous iron ores rendered prismatic by torrefaction. They are generally well defined, and easily separable from the mass they are engaged in; and often the fibres divide at equal distances from the centre, so as to detach portions of the spheroid in concentric coats. The transverse fracture of the fibres is compact and fine grained; the colour black; and the hardness somewhat inferior to that of the basaltic glass. When two of the spheroids come into contact by mutual enlargement, no intermixture of their fibres seems to take place; they appear equally impenetrable, and, as neither can penetrate, both are compressed, and their limits are defined by a plane, at which a separation readily takes place, and each of the sides is invested with a rusty colour. When several spheroids come in contact on the same level, they are formed by mutual pressure into pretty regular prisms, whose division is perfectly defined; and, when a

spheroid

spheroid is surrounded on all sides by others, it is compressed into an irregular polyhedron.

4th. The transition from this fibrous state to a different arrangement, seems to be very rapid; for the centre of most of the spheroids becomes compact, before they attain the diameter of half an inch. As the fibrous structure propagates itself by radiating into the unarranged mass, the compact nucleus which supplies its place gradually extends, till it finally attains the limits of the spheroids; and the same arrangement pervades the matter comprehended between them. The mass has now assumed a compact stony texture, and possesses great tenacity. Its hardness is somewhat inferior to that of the glass from which it was formed. Its action on the magnetic needle is very considerable. Its specific gravity is 2.938. Its colour is black, inclining to steel gray: it is absolutely opaque, and only reflects light from a few minute points. Though the divisions between the spheroids are rendered imperceptible to the eye, they are not obliterated, and their rusty surfaces are often disclosed by an attempt to fracture the mass.

5th. A continuation of the temperature favourable to arrangement, speedily induces another change. The texture of the mass becomes more granular, its colour rather more gray, and the brilliant points larger and more numerous: nor is it long before these brilliant molecules arrange themselves into regular forms; and, finally, the whole mass becomes pervaded by thin crystalline laminæ, which intersect it in every direction, and form projecting crystals in the cavities. The hardness of the basis seems to continue nearly the same; but the aggregate action of the basis, and of the imbedded crystals, on the magnetic needle, is prodigiously increased. It appears to possess some polarity; and minute frag-

ments are suspended by a magnet. Its specific gravity is somewhat increased, as it is now 2.949. The crystals contained in it, when examined by a microscope, appear to be fasciculi of slender prisms, nearly rectangular, terminated by planes perpendicular to the axis; they are extremely brilliant; their colour is greenish-black; they are harder than glass, and fusible at the blow-pipe; they are suspended by the action of a magnet. They are arranged nearly side by side, but not accumulated in thickness, so that they present the appearance of broad thin laminæ; they cross one another at all angles, but always on nearly the same plane; and the lamina thus formed is often three or four lines long, and from a line to a line and a half broad, but extremely thin *.

It seems obvious, that an equalized temperature would have rendered the whole similar to the substance last described; and it may be fairly inferred, that by a continuance of heat, the minute crystals would have been augmented in their dimensions, by the accession of molecules still engaged in the basis, or by the union of several crystals, till they acquired sufficient magnitude for their nature to be absolutely determined by the usual modes of investigation. It is probable, however, if such precautions had been taken as might have secured this degree of perfection in the ulterior result,

* It may be observed, that the cavities which existed in the glass are not obliterated during the subsequent processes, though their interior surfaces undergo some change. The minute globules first formed often become prominent, and project into the cavities. These minute points are soon obliterated by the large curves of the fibrous spheroids, which give a mamellated form to the interiors of the cavities; and, when the crystals are generated in the mass, they shoot into some of the cavities, and line them with their brilliant lamina.

that

that the mass would only have exhibited an uniform aspect, and that the interesting initial phenomena would not have been discovered *.

There are some considerations which appear to offer a partial explanation of the formation of the globules, and of the radiated spheroids. It is well ascertained that heat is emitted by all bodies, in their change from a gaseous to a fluid state, and also in their change from a fluid to a solid state. It is reasonable to suppose, that heat may also be emitted in those changes of arrangement which affect the internal texture of a body, after it has attained an apparently solid state. That a succession of such changes does actually take place, appears to me demonstrated by the appearances I have described, and by the increase of specific gravity, which seems to keep pace with the internal changes of the substance. It would appear, that these changes are caused by a gradual diminution of temperature, which permits certain laws to induce peculiar arrangements among the particles of the glass. When several of these particles enter into the

* In this and the succeeding paragraphs, the word molecule is used in the sense assigned to it by Hauy and Dolomieu, and is understood to represent the peculiar solids, of definite composition and invariable form, the accumulation of which, forms the crystals of mineral substances. Such molecules, preserving their form and their essential characteristics, may be extracted from most crystals by mechanical division, and may be subdivided as far as our senses can recognise them. Though we cannot by mechanical means directly divide them into their elementary particles, we are enabled to effect this by chemical solution, the only power to which their aggregation yields. It will be evident, from the observations that follow, that I am inclined to adopt the ingenious idea of Dolomieu, that many apparently homogeneous rocks are compounds of the minute molecules of several species of minerals; and that, where a suitable opportunity is given, these will develope themselves by the formation of their peculiar crystals.

new

new bond of association, they must form a minute point, from which heat must issue in every direction. That heat will gradually propagate itself, till the temperature of the glass is equalized; and then the recurrence of the circumstances which induced the first particles to arrange, will cause other particles to arrange also, which the attraction of aggregation will dispose round the point first formed. A second emission of heat in every direction will take place; the temperature will again be equalized; and again another concentric coat of arranged particles will apply itself to the little globule. But, at the time when the central point of this globule was formed, the equality of temperature, in the mass of glass, would probably cause a number of similar points to be generated. The formation of each must proceed in a similar manner to what I have described, till their surfaces touch, and all the glass be converted into the same substance.

These globules are therefore formed of concentric coats, but they are also radiated. Every one must have remarked the connection that almost uniformly exists, between the radiated structure and the formation by concentric coats. There are few radiated substances which are not divisible into concentric fragments; and as few concentric arrangements which are not radiated. Of the first, it may be sufficient to mention hæmatites; of the second, calcareous stalactites. The tendency to this union of structure, may perhaps be produced by the radiation of the emitted heat, or moisture, if the solution be aqueous; and the divisions of the coats will naturally take place at those pauses in the accumulation of particles, which the momentary emission of heat necessarily induced.

TO BE CONTINUED IN OUR NEXT.

Inquiries

Inquiries respecting the tinning of Copper, Pewter, and Pottery. By M. PROUST.

(Concluded from Page 217.)

M. FOURMY has published, in the Journal de Physique, vol. LV. a memoir on glazed pottery and other baked earthen-ware *.

I freely confess, that if I was extremely well pleased on perusing that memoir, with the theory which it has given us of the product of our arts in this line, I also saw with much pain that it has lost a little of its merit by the exaggerated opinions which it contains, and which want that rigorous accuracy from which a disinterested author ought never to depart †.

I do not see how the author can justify himself from the charge of exaggeration. He condemns without exception every kind of pottery, the English as well as the rest, and assures us that, not to mention their other defects, which are not inconsiderable, it is sufficient that their glazings contain metals to render them more or less dangerous.

* See the fourth volume of the present series of this work, p. 141.

† M. Proust transcribes here several passages from the memoir of M. Fourmy. This memoir is too well known in France for it to be necessary to insert them, and the more so as they are sufficiently indicated by the critical examination which follows. It is not necessary to apprise our readers, that we are far from being of the same opinion with M. Proust on this subject; they will soon perceive, that if the inventor of the *hygioceramcs* (wholesome pottery) has exaggerated the dangers of the metallic glazings, though he says in express words, *it would be exaggeration to pretend that a glazing which contains lead cannot possibly be innocent*, M. Proust has not less exaggerated the grounds of security in the use of glazed pottery in general, whilst some has been met with in commerce, which had all the appearance of the English clay, and which formed with vinegar acetate of lead, of which he himself cites an example. Note of the French Editor.

But

But would it not be better to set aside generalities which prove nothing, and to demonstrate their unwholesomeness by facts. To announce to the public that the wholesomeness will distinguish the *hygiocerames* of the author, or the new glazed pottery which he manufactures, from all other *glazed pottery and pottery that contain dangerous metals*, is really doing nothing more than giving a bad name to the productions of others, in order to recommend his own; but this is not demonstrating that ours are *toxicocerames* (unwholesome pottery.) Accordingly the complete security in which Europe remains in this respect, notwithstanding the publication of a memoir which appears to have been calculated to alarm it, is a proof that M. Fourmy, who has otherwise treated this branch of industry in a learned manner, has not yet obtained the confidence of the public in what he says relative to their insalubrity; and as long as his hygiocerames shall not be distributed over all Europe as substitutes for the ware which he condemns, all the world will continue to use the English pottery *.

But let us resume the examination of the opinions of M. Fourmy.

In the first place, arsenic is never employed as an ingredient in the glazing of pottery. If the painter who decorates it puts it into some colour, into the cobalt for example, in order to heighten its beauty, the arsenic is volatilized during the baking. This cannot be doubted; however, the name of arsenic is very well calculated to

* As the author has given so many proofs of sound logical reasoning, and is certainly not ignorant how slowly the most useful inventions make their way with the public, how could he conclude that that of the hygiocerames was opposed by general opinion, because it had not within a few months supplanted the productions of the manufactories of all Europe. Note of the French Editor.

strike

strike an alarm. Could this be the design of the author? I should be unwilling to believe it.

The other colours are applied with iron, tin, copper, lead, antimony, manganese, gold, silver, &c. The glasses of lead and of borax serve as their flux, and among these oxydes, those of lead, of copper, and of antimony, can create suspicions only with those persons who are ignorant that the vitrifaction causes their solubility entirely to disappear. Have lemon-juice, verjuice, vinegar, sorrel, salt, or the fats, ever been known to carry away with them any particles of these oxydes? Has any one seen the colours of the glazings dissolve or disappear suddenly or in the course of time, even after many years? It is the friction of the knives and forks, and the scowering with sand, which continually wear off the enamel; but the aliments cannot do it, since they cannot dissolve it *. This is a fact which is open to the eyes of every one.

Sometimes oxyde of copper is mixed in the glazing to give it a green tinge; this colour is applied to the outside of the ware, generally for soup-dishes, coffee-pots, cups, &c.; but it is always so well dissolved and vitrified by the oxydes of lead, of tin, and sand, that there is no example of the aliments having carried away the smallest portion of it. The glazings which are liable to crack and separate in small leaves, and which open a passage to the liquids, whereby they penetrate into the paste so as to spoil and contaminate it with a burnt taste, which, in short, have all the defects with which M. Fourmy re-

* It is far from being an universally admitted principle, that the vitrified oxyde of lead is unattackable by the vegetable acids, with the aid of heat. In a subsequent note a proof shall be adduced to the contrary, which M. Proust will not be able to controvert. Note of the French Editor.

proaches them, keep nevertheless with all their colours as long as the pottery lasts.

With respect to the white glazing composed of oxydes of lead, of tin, of sand, and of salt, how should it be capable of being attacked by the alimentary acids, since nitric acid, at 30 degrees, when kept in a plate of glazed pottery for the space of forty-eight and sixty hours, cannot separate from it any metallic parts capable of being estimated, nor even deprive it of its brilliancy.

I have found some glaged pottery from which nitric acid, after having remained in it for a long time, separated some lead, but in such small quantity, that the sulphate of potash was unable to precipitate it: it required the application of a stronger and more certain re-agent, such as sulphurated hydrogene, in order to render it perceptible.

The more common pottery has, in this respect, the same advantages as the best. We must take care not to confound it with mere glazed earthen-ware, which does not by any means equal it, since the glazing of the better sort receives two vitrifactions; the one for the purpose of affecting the reciprocal solution of the three ingredients which are employed in it, and the other to fuse the glass which results from it, and which remains upon the surface of the paste. This enamel, though more surcharged with lead, and more tender in the vessels destined for cooking victuals, than in those which serve only for the table, acquires nevertheless the property of preventing the action of the acids, by reason of the hardness which the vitrifaction has communicated to it, and the smoothness of its surface. In order to corrode it, it would be necessary to reduce it to powder, and to boil it with the acids. In that case it would certainly dissolve; for the hardest glasses cannot resist this operation.

Moreover,

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Moreover, as we do not eat any thing prepared with nitric acid, there is no instance of our glazed pottery, either fine or common, having communicated to the aliments any thing that could prove injurious even to the most delicate health. We may therefore continue to use all wares of this kind with the utmost confidence, and as long as the arts shall not have furnished us with any more perfect, we may safely say that we eat out of *hygiocerames*.

I shall now reply to the fourth assertion of M. Fourmy. The lustre of the glazings is an effect inseparable from all glass, of whatever kind it be, or of every bath of glass well fused upon the paste. This is a quality very independent of the oxydes of lead, and which will never enable us to judge whether the latter abound more in one glazing than in another. As to the colour, which he says is of a disagreeable olive cast, I ask the readers who see this ware daily upon their tables, whether they have ever formed the same opinion.

Let us consider the fifth assertion. If this glazing be capable of resisting the nitric acid, how should it yield to that of the lemon, to vinegar, and to verjuice? It must be admitted, moreover, that the disasters which are occasioned in course of time by this poison are very slow and very rare; for we never hear of any physician being called in in order to stop the progress of accidents occasioned by the English pottery.

M. Fourmy advances, in his sixth assertion, *that hard bodies scratch this ware*. The point of the knife would need to be well steeled, and to be applied with great force, in order to produce any scratches in this glazing; but scratches are produced also upon silver, crystal, and porcellain. Are these defects sufficient to authorize a proscription of the English pottery? The liquids pene-

trate into the paste, &c. This is a defect that has been observed in the pottery of the manufactory of Pont du Choux, at Paris; but it is only a supposition with regard to the English pottery.

He assures us, in his seventh assertion, *that these wares have little durability.* He is sure that if we let a plate fall to the ground it will break to pieces; and certainly it is only these accidents that prevent our seeing the destruction of the glazing. Would the hygiocerames of Fourmy last longer in this respect than a plate of pottery.

Finally, he concludes, in his eighth assertion, *that he has demonstrated that both of these kinds of pottery are dangerous.* M. Fourmy is in the right as to the first: it is a fact which has long been known to all Europe; but as to glazed and English pottery, their reputation has hitherto not suffered the slightest blemish.

Latterly the application of glass in powder for glazing pottery has been announced as a new discovery. This happy idea belongs to M. Chaptal, who, since the year 1789, has put it into execution in his manufactories.

I hope, he says, that if this process is introduced into the workshops, it will soon receive every degree of perfection of which it is capable: two powerful motives ought to induce the artists to occupy themselves with it. The first is, that this glazing is attended with no danger; the second, that it is less expensive. The interest of the public, and that of the manufacturer, both afford reason to hope that it will be adopted, and I hope that the period is near at hand *.

Conclusion.

* This passage, of which M. Proust does not mention the source whence he has taken it, is to be found in a memoir inserted in the second volume of the "Annales de Chimie," p. 26. The use which he makes

Conclusion.

The project of using zinc as an ingredient in the tinning of culinary vessels and utensils is already an old one; it appears that Dr. Malonin was the first who suggested the idea. The danger resulting from the use of copper has revived it from time to time, as we see from the different tinnings and alloys proposed to academies, and in commerce, and latterly by M. Buschendorf, at Leipzic.

Though the accidents with which lead seems to threaten us, when it enters in too great quantity into the tinning, ought to concur with those occasioned by the copper, to cause zinc to be immediately adopted as the more wholesome, no person in Europe has yet tried it.

The general agreement of all nations, in this respect, sufficiently proves that its inconveniences have been perceived; and they are indeed numerous.

1. Zinc dissolves more speedily and more easily in the alimentary acids than iron, copper, tin, and lead.

2. It has a disagreeable taste, probably of an emetic nature, which its solutions communicate to the aliments;

makes of it requires some observations from us. 1. It is not merely glass, it is the fusible clay of Murviel and glass reduced to powder, which form the composition of M. Chaptal's glazing. 2. If it should be said, "it is fifteen years since this process has been published, and it is not adopted throughout all Europe, consequently it is opposed by the general opinion," M. Proust would surely not approve of this manner of reasoning, which nevertheless would only be the application of one of his arguments against the hygiocerates. 3. Finally, we read in the same memoir the following passage, which proves at least that M. Proust was not authorized in advancing as a principle universally received, that the glass of lead is insoluble by the matters which enter into our aliments: "Every one knows how dangerous the metallic glazings are, since the acids, the oils, and the fats, have a very decided solvent action upon them." Note of the French Editor.

which

which agrees with the opinion of the German physicians, who prescribe it as a purgative.

3. The ordinary impurity of the zinc of commerce: in Germany, from whence it is obtained by all the rest of Europe *, it is extracted indirectly from the minerals with which it is combined, such as iron, copper, lead, and arsenic; these metals, though in small quantity, cannot fail to increase the repugnance which has every where been excited against its use.

4. Zinc, mixed with tin, in a proportion inferior to that prescribed by Buschendorf, forms an alloy which is decomposed in fusion by the approximation or crystallization of the particles of the first. Hence results, with the copper articles to which it is applied, a rough tinning, full of granulations which refuse to incorporate with the tin, and which cannot be made to disappear without hammering the pieces; an operation which accelerates their destruction, and which alone would be sufficient to double the price of the tinning.

5. This tinning, which is so difficult, and the success of which is uncertain even with small articles, is impracticable with those of a middling and large size: it burns with the greatest rapidity, and it leaves them covered with a black scoria, which cannot be removed without scraping them afresh.

6. The alloy of zinc with tin, in equal parts, is likewise not of such a nature as to admit of being wrought at pleasure; and as it also has the defect of suffering the zinc to be dissolved with extreme facility, it has justly been condemned wherever it has been proposed. In short zinc, compared with tin, as a metal proper for guarding

* I was unable to obtain zinc of Alcar for the purpose of examining its purity.

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us against the danger of copper, has nothing to recommend it.

Lead, a dangerous metal when oxydated, is not so formidable when taken in the metallic state. At least no well-authenticated case has been adduced which can afford reason to be alarmed at having swallowed grains of tin more or less charged with lead, or particles detached from utensils by the friction of the spoons, or, finally, shot, notwithstanding the arsenic contained in the latter.

The alloying of lead with the tin used for tinning renders the former less susceptible of solution in the alimentary acids than has hitherto been imagined; but we ought chiefly to keep to the tinning with fine tin, as it is more salubrious in every state, and very well adapted for securing us against the copper, without its being necessary to have recourse either to zinc or lead.

There are nevertheless several circumstances in the brazier's art which render an alloy of 4 or 5 parts of lead to 100 of tin, indispensibly necessary both for the tinning of irregular pieces and for strengthening the bottoms of certain domestic utensils, the making of which afresh, without any particular utility, would prove very burthensome to the indigent.

The tinnings, which are too much charged with lead, can hardly expose the health to any danger. It is to the want of attention in having the utensils new tinned as soon as they require it, rather than to any fault of the tinning itself, that the dangers of which we here speak are to be attributed.

The body of artisans who use copper vessels for the boiling of sugar, and all the alimentary and medicinal preparations in which it is an ingredient, could not submit to use the same method of tinning which is employed for domestic purposes; because, in works on large scales, there

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there occur causes of a more rapid destruction, which cannot be prevented. The only means of ensuring the public safety in this respect, is by an appeal to the conscience and the humanity of the persons who practise these arts, and by punishing severely those who, for want of vigilance, should be so unfortunate as to endanger the lives of their fellow-citizens.

As to the copper measures which are still at the present day in use for selling oil, the interest of the public health loudly demands that they should be speedily and entirely prohibited. The case is not the same with regard to the buckets which are used for carrying water into the houses, for not to mention that there is no instance of their having occasioned the slightest accident, the water of Madrid has the property of incrusting the interior of the vessels with an earthy deposition, which performs the office of the best tinning.

The scarcity of fuel may be an obstacle to the bringing to perfection of the vessels made of the clay of Alcorcon. The potter therefore who should succeed in improving this manufacture, as well as the person who should discover in the environs of Madrid a clay of the same quality as that of Zamora, which does not require to be glazed for the common use of the kitchens, would acquire a just claim to the public gratitude.

The Alcorcon earthen vessels ought not to be used in the extraction of the juice of lemons, of verjuice, and other similar substances. Those, therefore, who prepare these juices for the purposes of sale ought indispensibly to prepare them in vessels of unglazed earth, of glazed pottery, of tin, or in wooden tubs.

M. Fourmy has endeavoured to excite apprehensions with respect to the English pottery and pottery in general; but his assertions are altogether exaggerated.

Method

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Method of obtaining the greatest possible Effect from a first Mover, of which the Energy is subject, to increase or diminish, within certain Limits, and in general to vary at pleasure the Resistance to which the Effort of the first Mover makes an Equilibrium in any Machine whatever, without changing the Mechanism of the Machine.

By R. Prony.

With a Plate.

From the Bulletin des Sciences.

THE problem of mechanics, of which the solution is here given, is one of the small number of those which, leading to results independant of the particular mechanism of the machine to which they are applied, offer, in their solution, a generality which may be compared with that of rational mechanics or analysis.

It may be expressed as follows.

"Any machine whatever being constructed, to find, "without changing the mechanism of the machine, a "method of transmitting to it the action of the first "mover, by observing the following conditions, *viz.*

"1st. That it may be possible, at pleasure, and with "ease and promptitude, to vary the resistance against "which the effort of the first mover ought continually to "make an equilibrium within the limits of any extent "that may be required.

"2dly. That the resistance, once regulated, may "maintain itself rigorously constant until the moment "when it shall be judged proper to increase or diminish "the same.

"3dly. That, in the sudden variations of which the "effort of the first mover may be capable, the variation

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" of the speed of the machine shall never experience a " solution of continuity."

I am now going to apply the solution that I have discovered of this problem to the dynamic effect of wind. It will be easy to make the same general when the other first movers shall be employed.

O O, Plate XIII. is the vertical arbor to which windmill sails are adapted. *e e e e*, is an assemblage of carpentry of which one of the spokes O *e* carries a curved piece *b d*, of iron or steel.

Vertical axes of rotation *a*, &c. placed round at equal distances of the axis OO, divide also, into equal parts, the circumference in which they are found. Each of these axes carries a curved piece *a f*, of iron, steel, or copper, in such a manner that, when the wind acts upon the sails, the curved piece *b d* presses upon one of the curved pieces *a f*, and causes a portion of a revolution of the vertical axis to which it is fixed.

The curved pieces *b d* and *a f* ought to be disposed in such manner that *b d*, pressing on one of the curves *a f*, begins at the same instant to act upon the curve following. The number of axes which carry these curved pieces must be determined according to the particular circumstances of each case. We may also substitute for *b d* a portion of a toothed wheel, having its centre in the axis O O, and place portions of pinions instead of the curved pieces *a f*; but the disposition represented in the figure is preferable.

Each of the axes *a* carries a drum wheel *r r r r*, (see Fig. 2, which represents an elevation of one of the axes *a*, Fig. 1, which is the plan,) on which is wound a cord, that passes over a pulley *p*, and which holds suspended Q by means of the lever P G, upon which this weight may be

be slid and placed at different distances from the point of support G.

The same axes $a\,a$ pass through the pinions $q\,q$, to which they are not fixed; but these pinions $q\,q$ carry ratchets, which bear against the teeth $r\,r$, in such manner that when the weight Q tends to raise the ratchet yields, and there results no other movement of the axis a and drum wheel $t\,t\,r\,r$, than the ascension of the weight Q, nor any action on the pinion $q\,q$. But from the instant that the curve or tooth $b\,d$ ceases to bear against one of the curves or teeth $a\,f$, after having caused the corresponding weight Q to rise, this weight Q tends to redescend, and then the set of teeth $r\,r$ act against the ratchet, so that Q cannot descend without turning the pinion $q\,q$ with the drum wheel $t\,t\,r\,r$.

The pinion $q\,q$ works into the wheel A B, from the motion of which immediately results the useful effect of the machine; thus the effect of the descent of one of the weights Q is to solicit the wheel A B to motion, or to continue the motion jointly with all the other weights Q, which descend at the same time. This wheel A B has oblique teeth G D underneath, which work into the the teeth of the wheel C E, which causes the buckets S to rise.

The alternate motion of these buckets may be effected by the mechanism that I have described in the first volume of the Memoirs of the Institute.

It may be seen from the preceding description, that the machine being supposed to start from a state of rest, the wind will at first raise a number of weights Q sufficient to put this machine in motion, and will continue to raise new weights, according as those heretofore raised shall fall; so that the motion once commenced will be continued.

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Among the numerous advantages of this new mechanism we may remark the following.

1. It will never be subject to any violent shock or jerk in any part of the mechanism.

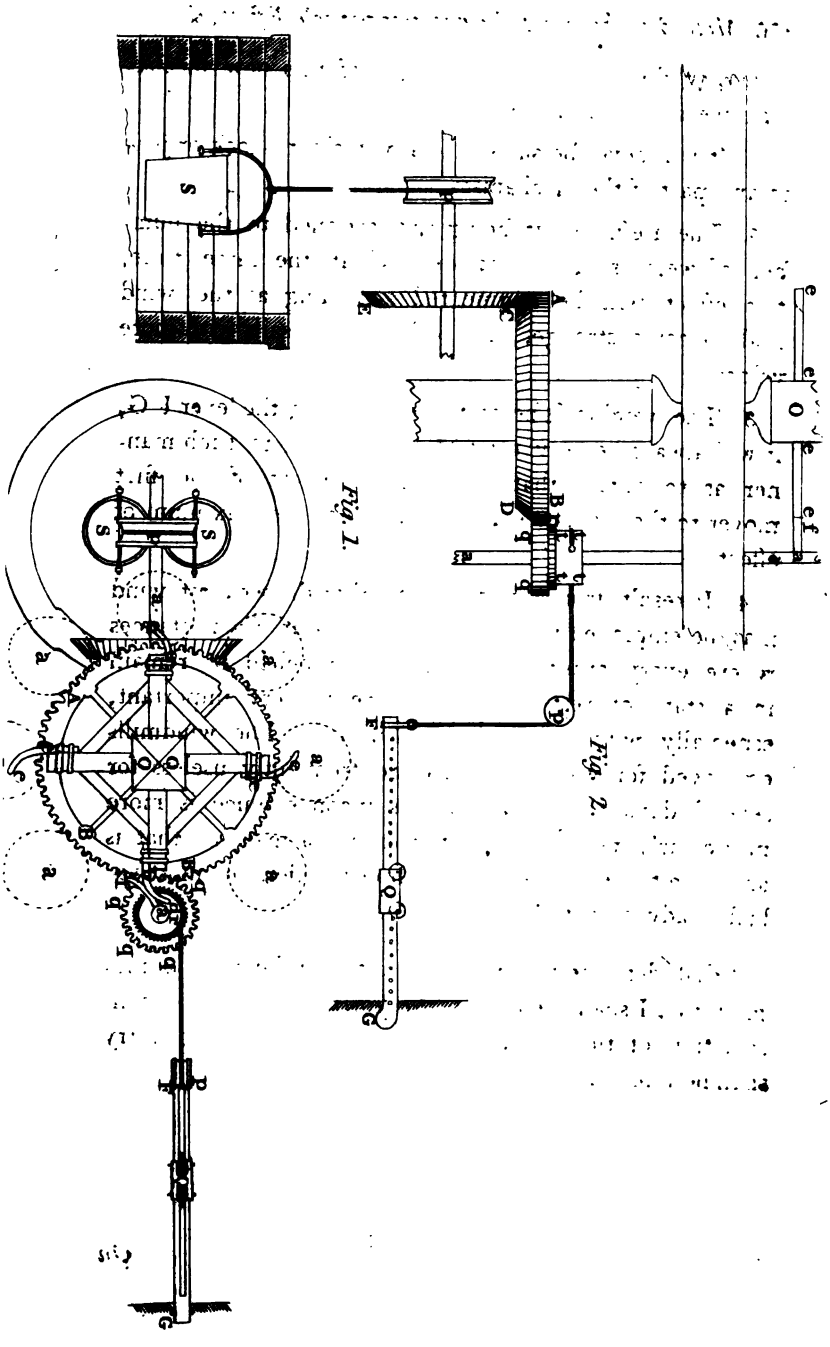
2. The useful effect being proportioned to the number of weights Q, which descend at the same time, this effect will be augmented according as the wind shall become stronger, and will turn the sails with more velocity.

3. The weights Q being moveable along the lever F G, it will always be very easy to place them in such manner as to obtain that ratio of the effort of the first mover to the resistance as shall produce the maximum of effect.

4. It results from this property, that the weakest wind may be employed to move this machine in circumstances where every other windmills are compelled to remain in a state of rest; this advantage is very important, especially with respect to agriculture. The windmills employed for watering lands are frequently useless for several days together, and this inconvenience is more particularly felt in times of drought: a machine that is able to move with the slightest breeze offers the most valuable advantages.

I shall describe this machine more at large in a memoir that I shall present to the Institute when the construction of the machine I am erecting in the country shall be finished.

On



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On a new Process for preparing the Black Oxyd of Iron (Martial Ethiops); *followed by an Examination of this Oxyd, and of its Employment in some pharmaceutical Compounds.*

By Messrs. TRUSSON *and* BOUILLON-LAGRANGE.

From the ANNALES DE CHIMIE.

IRON is a metallic substance, which furnishes a great number of preparations of much utility in various diseases. But there are some among them, the processes for which are varied at the pleasure of the persons who prepare them, which, at first sight, must appear very astonishing to chemists and physicians. This surprise will, however, soon cease, when it is known that, to the present day, chemists have not yet come to an unanimous decision respecting that which appears to be of the greatest importance in medicine, the martial ethiops of Lemerg; for it is to him that the discovery of it belongs. His process, which is well known in chemistry, furnishes a good ethiop, but it requires a considerable time to obtain a very small quantity of it, besides which it demands innumerable precautions, and has likewise the disadvantage of passing very frequently into the state of oxyd. The chemists, who have long been aware of these circumstances, have endeavoured to remedy them by proposing new methods for preparing this medicine, both in order to abridge the operation, and to obtain a larger quantity in less time. M. Majault is one of the first after Lemerg who has given a process; which consists in mixing with the sulphate of iron any fat substance. This process would be a tolerable good one, were it not attended with two very considerable inconveniences. The first, which is the least, is that the whole of the oxyd

of

of iron employed is never reduced to the state of black oxyd; the second is, that this ethiops retains a smell of muriatic, which the longer it is kept becomes the more repulsive. M. Jacquin has also proposed to heat to redness the oxyd of iron resulting from the precipitation of the martial salts by the alkalies with olive oil, or any other fat matter. This process is attended with the same inconvenience. Messrs. Rouelle, Croare, and others, have added to the process of Lemery a certain quantity of either vegetable or mineral acid to the water used in the operation.

This addition may promote the oxydation of the filings, but the oxyd is never pure, and the operation is always very tedious.

M. Baumé had advised to put iron filings into a pan of earthen ware, to cover them with about an inch or two of water, to place the pan in a moist situation, guarded from dust, to put fresh water into the pan in proportion as it evaporated, and not to stir the matter. When it is to be presumed that there is no more moisture, the surface, which is rusted, is removed, and put apart, and under this portion are found the dry filings, which are perfectly black; these are then pulverized.

Josse, a practitioner of pharmacy in Paris, has communicated to the Royal Society of Medicine, a process for speedily obtaining martial ethiops. He recommends to heat to redness the *aperient crocus of mars* (carbonate of iron), in a retort, to which is adapted, without luting, a receiver perforated with a small hole: by this means the heat disengages the carbonic acid, which M. Josse suffers to escape through the hole in the receiver, and the iron remains in the state of black oxyde in powder.

M. Maret, a member of the Academy of Dijon, and afterwards Van Mons, have proposed to precipitate the

sulphuric

sulphuric or nitric solution of iron by ammoniac, to wash the precipitate, and to dry it quickly in close vessels. This precipitate is never of so deep a black as the ethiops ought to be; besides which, is it not an acknowledged fact, that precipitates always retain a portion of the substance which has served to form them? The experiments of Messrs. Fourcroy and Darcet give additional support to these observations. (See Memoires and Observations de Chimie par M. Foutcroy.)

Several other processes have also been proposed for some years past.

M. Carny, and before him M. Flamont, an apothecary at Paris, has advised to impregnate water with an arbitrary quantity of iron filings so as to make them into a paste without excess of liquor; at the end of twenty-four hours to be absorbed, and the matter almost entirely dry, to this added a new portion of water, and this operation is repeated till the whole of the iron is reduced to a fine black powder; this powder is thrown into boiling water, and after the grosser matter has been suffered to subside, it is decanted, and the precipitate is dried.

M. Deroaver has improved and abridged this process, by employing half-oxydated iron.

M. Vauquelin has also described a method for the preparation of ethiops. It consists in taking two parts of iron in fine powder and one part of red oxyde of iron, putting the mixture into a crucible, and heating it strongly for the space of two hours.

Finally, M. Save has proposed to take beatings of iron, to porphyrize them with a little water, to heat them in a crucible to desiccation, and then to add a little oil.

Though the processes which we have just enumerated are, in general, good, yet it is no less certain that they vary

vary in their results, in colour, in smell and in solubility, either in some ferruginous preparation, or in the manner in which the acids act upon these oxyds.

If we add to these considerations, the more or less considerable space of time which must be employed in order to obtain them, and the various quantities which are obtained by one or the other of these processes, it will be conceived of how great importance it is to reduce to certain rules a preparation, from which medicine derives great advantages in several diseases.

By proposing a process at the same time simple and easy, invariably affording the same degree of oxydation, and requiring but a very short time to obtain a large quantity, we conceive we shall gratify the wishes of apothecaries and all those who study the healing art. Uniformity in processes cannot but be of advantage to physic; when this point is attained, the effects that may be expected from medicines will be more certain.

It is about sixteen years since M. Trusson prepared an ethiops, the process for which we are going to describe. After the examination we had made of it, we thought that it might be interesting to examine this oxyd again, and to make some experiments not only on that prepared at such a remote period, but likewise to compare it to others.

This ethiops, kept in a vessel very carelessly covered, had experienced no alteration. We ascertained that there is no difference between the oxyd prepared sixteen years since and that of late preparation.

This trial of sixteen years is quite sufficient to prove the superiority of this oxyd over Lemerg's ethiops, or others made by known processes. It is certain that these kinds of ethiops in general readily absorb the oxygen of the

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the atmospheric air which produces a very remarkable change in the colour.

The process. Take purified sulphate of iron, dissolve it in eight parts of boiling distilled water, and filtre.

Dissolve likewise one part of crystallized carbonate of soda, in eight to ten parts of water, and filtre.

Then pour by degrees the carbonate of soda into the solution of sulphate of iron; a slight effervescence is occasioned by the disengagement of a portion of carbonic acid. The first part of the carbonate of soda added to the liquor produces a precipitate of a bright green; the colour of the succeeding precipitates varies and assumes different tints; and in general the greater the quantity of the sulphate of iron decomposed, the darker is the colour of the precipitate.

The precipitate must then be levigated till the water from the levigation produces no alteration either in gallic alkohol or muriate of barytes. Afterwards dry it with a gentle heat, and add to each ounce of this substance three drams of acetic acid diluted with water (distilled vinegar), which occasions a slight effervescence. Mix it well and introduce the whole as speedily as possible into a stone retort covered with a luting of clay, or an iron retort; place it in a reverberating furnace, and adapt to it a tube and a tubulated receiver, provided with a curved tube, which must be immersed in water. Having carefully luted all the crevices and joints (a very necessary precaution), heat by degrees, so as to produce a powerful heat towards the conclusion of the operation; for the quantity of half a pound, it ought to be continued almost two hours. A liquor passes over, which is transparent and has a slightly-empyreumatic smell; it is not acid and has an insipid taste. Prussiate of potash produces in it no alteration; it forms a precipitate with

lime-water. Some carbonic acid is likewise disengaged during the operation.

In the retort you find a bulky matter of a very beautiful black, pulverulent and very soft to the touch.

This ethiops produces no sensible effervescence with acids, even though it may have been made for a considerable time and preserved in close vessels.

If exposed to the air for a fortnight, effervescence is produced by acids without any change of colour.

The ethiops, prepared by the common processes, imbibes a very great quantity of oxygen, which causes it to turn brown. This absorption is still more striking, when it is boiled in water.

Black oxyd prepared by the process above described soon turns brown, and afterwards passes to red, when it is heated. The colour it assumes is more brilliant than that which under similar circumstances the ordinary kinds of ethiops would exhibit.

Sulphuric acid exercises very little action when cold on this oxyd, but it passes successively to red by the aid of caloric, and its total dissolution afterwards takes place; the liquor turns to a brownish red. This dissolution is accompanied with effervescence when the oxyd has been exposed to the air.

Alkaline carbonates, pure alkalies, and lime water produce a brownish precipitate.

Prussiate of potash and gall nuts turn the solution to a dark blue.

Nitric acid dissolves this oxyd without the disengagement of any elastic fluid. It requires to be heated for some time before a complete solution of the oxyd can be effected.

Muriatic acid rapidly dissolves it; a very small quantity of carbonic acid is disengaged if the oxyd of iron has

has been exposed to the air; but there is no disengagement when the oxyd has been newly made or preserved in close vessels.

The solution of this oxyd in sulphuric and muriatic acids always yields a very small quantity of oxyd of carbon; a dram of black oxyd gives about one grain and a half of oxyd of carbon.

With a view to examine the difference that might exist in the preparation of certain medicines, we made, in the first instance, martial boluses called *boluses of Nancy*.

The boluses prepared with this oxyd are very black and are easily made smooth; they have a sweetish astringent taste, readily dissolve in water, and leave behind a very small quantity of insoluble matter.

The solution exposed to the air always preserves a dark green colour, and does not change turnsol.

Those prepared with iron-filings are not so easily dissolved in water; the liquor is yellowish. The most abundant precipitate forms three distinct layers.

The first is a very delicate substance which is kept suspended by the water. After having been filtered, there remains on the filtre a yellowish matter, which when dry has a yellow colour.

The second consists of acidulated tartrite of potash, mixed with a small quantity of tartrite of lime.

The third is composed of iron; it has its metallic lustre, is attracted by the loadstone, and dissolves in sulphuric acid with a disengagement of hydrogen gas.

If, in the second place, this oxyd be employed to prepare martial tinctures, called *Ludovic tinctures*, or tartarised tinctures, it affords this advantage, that much less time is required for their preparation.

The crystals of chalybeate tartar, obtained by former processes, are always of a yellow, more or less pale; sometimes they are even of a dusky grey.

Those obtained by employing oxyd are always of the same colour; they are of a fine golden yellow, and dissolve in water without forming any precipitate.

Prussiate of potash and infusions of gall-nuts produce with it a darker blue than that obtained by taking chalybeate tartar prepared with iron-filings.

All these experiments obviously demonstrate the preference that ought to be given to the ethiops which we propose, not only on account of its constant beauty, but likewise for the quantity that may be obtained in a very short time.

To the above qualities, we have likewise discovered that it adds that of forming, under some circumstances, a substitute for iron-filings, either with tartaric or with any other acid. The combinations resulting from it are more regular, and in general these kinds of preparations are more speedily made.

On some other properties that we have discovered in this oxyd, we shall be silent. We have already ascertained that it might be employed, and with great utility, in different arts.

We shall resume this subject when we have completed our experiments. As that accuracy which ought always to be studied requires that they should be repeated and examined with great care, we think it our duty to defer the details of them to a future memoir.

* One hundred and ten pounds weight of the French hundred weight.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

Preparation of Tan.

THE Society for the Encouragement of Arts, &c. has lately presented their gold medal to Dr. Howison, for the preparation of tan made in the East Indies from the bark of the Mangrove tree.

The method followed by him in its preparation is very simple, and applicable for extracting the tanning principle from vegetables on the most extended scale.

In extracting the tanning principle from the Mangrove bark, Dr. Howison made use of part of an apparatus which he had formerly employed in refining saltpetre. This consisted of four wooden cisterns, resembling the coolers used in brewhouses, fitted with cocks, and sufficiently elevated one above another to admit of any liquid contained in a higher cistern, running off into that immediately under it, on turning the cock.

In preparing the tan forming the specimen sent* Dr. Howison, according to the principles laid down by M. Seguin, divided four hundred pounds of Mangrove bark (broke into small pieces) into three equal parts, one of which was thrown into each of the three highest cisterns.

To the bark in the uppermost cistern one hundred gallons of rain water was added, which was allowed to re-

* One hundred and ten pounds weight have been imported by Dr. Howison, and a specimen of fifty-four pounds deposited in the Society's repository. The specimen cost about eight shillings in Bengal; but if the demand for the article be considerable, it would be procured for ten shillings the hundred weight.

main

main for twelve hours. The infusion was then drawn off into the second, and after standing for a similar period into the third, and lastly into the fourth, which had been kept empty to receive the saturated infusion, to be further concentrated by evaporation. The cocks belonging to each cistern, when once turned, were left open to admit of the infusions draining off completely.

The whole of the liquid now collected into the evaporating cistern was exposed to the heat of the sun, until concentrated so as to resemble thick syrup, at which time the lixivium was reduced to about eight gallons. It was then drawn off clear from its precipitate into a copper boiler, in which it was boiled on a slow fire, and kept constantly stirred, until the extract acquired a consistence that would just admit of its being poured into the barrel, where on becoming cool it had the appearance of pitch, which it still retains. When the infusion had acquired the thickness of syrup, I found the use of fire for giving the necessary consistence to the extract, preferable to waiting the farther progress of evaporation, that being in a great measure suspended by the successive formation of tough coats on the surface of the liquor.

Dr. Howison has made a similar extract from Myrobolens, which is likely to be extremely useful, both for tanning and dying.

Manure.

The neighbourhood of Gottenburg has lately experienced a wonderful improvement by the use of the refuse of herring oil works as a manure. Its stench, infinitely more offensive than night-soil, does not deter the farmers from carrying it fifty or sixty miles in waggons. It is said that ten barrels, of sixty gallons each, is sufficient for one Swedish acre, after being diluted with a sufficient quantity of water. In all places where herrings or pilchards

are

are salted, much of this kind of manure may be obtained; and it is presumed that it may be had most plentifully at Yarmouth, and such places in Scotland as prepare red-herrings for sale. This composition differs in no respect from the refuse of whale-blubber, excepting in its containing a portion of sea-salt, which probably may increase its virtues by an increase of stimulus.

List of Patents for Inventions, &c.

(Continued from Page 332.)

EDWARD SHORTER, of New Crane, Wapping, in the county of Middlesex, Mechanic; for a mechanical apparatus, by which the raising of ballast is rendered more easy, cheap, and expeditious, and which may also be applied to other useful purposes. Dated January 16, 1805.

WILLIAM LESTER, of Piccadilly, in the county of Middlesex, Engineer; for an improvement on an engine or machine for separating corn, seeds, and pulse, from the straw. Dated January 16, 1805.

SAMUEL CHITTEY, of Newmarket, in the county of Suffolk, Rider; for improvements upon bits of bridles. Dated January 16, 1805.

THOMAS HAMILTON KEDDIE, of Duke-street, Grosvenor-square, in the county of Middlesex, Sadler; for a cartouch-box, or receptacle for cartridges of gunpowder, or gunpowder and ball, for charging musquetry or artillery, or any other description of fire-arms. Dated January 19, 1805.

EDWARD THUNDER, of Brighthelmstone, in the county of Sussex, Gentleman; for an improved mode or method of

of keeping in tune certain musical instruments called piano-fortes, grand piano-fortes, harpsichords, spinnets, and other stringed instruments.
Dated January 23, 1805.

JOHN ROBERT LUCAS, of Charlton-house, in the county of Somerset, Esquire; for an improvement in the art or method of making, spreading, or flattening sheet-glass, commonly called German sheet-glass, plate-glass, or any other spread glass requiring a polished surface.
Dated January 23, 1805.

JOHN JONES, of the city of Chester, Chemist; for a liquor for printing and dying of cotton, linen, and woollen.
Dated January 23, 1805.

FREDERICK MOLLERSTON, of Hackney-wick, in the county of Middlesex, Gentleman; for a chemical composition, and method of applying the same, in the preparation of hides, skins, and leather, silks, taffetas, and linen, and to all articles already made of skins and leather, thereby colouring and giving a beautiful gloss to the same, rendering them water-proof and impenetrable to hot or corroding liquids, and at the same time preserving them from decay, and keeping them soft and pliable. Dated January 23, 1805.

SIMEON THOMPSON, of Redcross-wharf, Upper Thames-street, in the city of London, Coal-merchant; for a bushel or bushels, and other measures, upon a new construction, for measuring coals, grain, seed, and other dry measurable commodities.
Dated January 23, 1805.

JAMES BARRETT, of Saffron Walden, in the county of Essex, Smith and Iron-monger; for an improvement in the construction of malt-kilns, so as to prevent damage from fire, and to save fuel in the drying of malt.
Dated January 29, 1804.

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THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. XXXV. SECOND SERIES. April 1805.

Specification of the Patent granted to ROBERT BROWN, *of the Town and County of the Town of Nottingham, Lace Manufacturer; for a Machine to be affixed or attached to Horizontal Warp or Vandyke Knitting Frames, for the Purpose of manufacturing, by a more simple, neat, and expeditious Method, Lace or Nett Work of various Figures and Qualities, with Thread, Silk, Cotton, Worsted, or other Material produced from Animal, Vegetable, or Mineral Substances.*

Dated May 14, 1804.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Robert Brown do hereby declare that my said invention is described by the plans or drawings hereunto annexed, (Plate XIV.) and in manner following; that is to say: Letter F is an entire perspective of the said machine attached to the horizontal warp or vandyke knitting-frame. Figs. 1, 2, 3, 4, 5, 6, are drawings

ings of the minute parts of the separate pieces of machinery, composing together the said machine, which I describe and explain in manner following; that is to say:

Fig. 1, represents the main bar of the said machine (with the handles to work it) separated from the other bars with which it is when working connected. It is supported at the ends upon two axles (denoted by letters *x x*), which enter a hole in each of the cranks of a crank-bar, in the same manner as in the old horizontal warp-frame; one of the axles is moveable (as represented by the figure of the axle at X), for the greater facility of taking off or putting on the bar. Letters S S, are two slots screwed on the front-edge of the bar, in order to admit the screws of the telegraph (another part of the said machine hereinafter described), and represented in the said drawings by letters S S, Fig. 4. *b b*, are two catches, with an upper and lower stop in each, for holding down the thumb levers attached to the falling bars, (other parts of the said machine hereinafter described and represented in the said drawings, by the letters *a a*, in figures 2 and 3), when the said thumb levers are put under the lower stops of the said catches. Letter *m*, is a stop similar to one used in the said old warp frames to keep up the machine. Letter *n*, is a stop similar also to one used in the said old warp frame, to regulate the distance at which the guides shall enter the needles when laying the threads. A, (underneath one end of the figure 1) represents one of the end bits slotted, two of which are affixed to each end of the said main bar, next to the stops *m* and *n*, by screws inserted at the points *a a*, in Fig. 1. In these end bits the axles of the said falling bars, represented by letters *a a a a*, in Figs. 2 and 3, are supported, and work, being received into holes perforated

in

in each of the said end bits, tapped on the outside to admit a regulating screw. The end bits supporting the upper falling bar are placed with the perforated parts upwards; those supporting the lower falling bar are placed with the perforated parts downwards. Underneath the centre of the main bar is a tapped hole to receive the screw W, of the swing bar, as represented hereinafter in Fig. 5.

Fig. 2, represents the skeleton of the bottom falling bar with tapped holes for the screws, which fasten the leads.

Fig. 3, represents the top falling bar, with the leads screwed upon its upper surface. Letter K, is a single guide lead with its guides cast in it; O is a single guide; P is a pioneer lead with the pioneers cast in it; Q is a single pioneer. The guide leads on the bottom falling bar are screwed to the under surface, and underneath each of these by the same screw is fastened the pioneer lead with the face P downwards. The pioneers are for the purpose of separating threads in their approach to the guides, so that the guides may fall freely; their number is equal to the guides on one bar, or to half the number of needles in the frame. The letters *a a*, in Figs. 2 and 3, are two thumb levers, one on each falling bar, and are opposite or near to the handles on the aforesaid main box when the machine is put together. They are for the purpose of raising or letting down the respective falling bars as hereinafter represented, under the description of Fig. 4; and they are so attached to each of the said falling bars by a screw, as to have play sufficient for being thrown off or put under the stops of the catches.

Fig. 4, represents the telegraph bar, and the handle by which it is moved. It is a slide moving above the

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before described chain-bar, and is attached to it by means of the screws (S S, which pass through the slots *x x*, (represented by the letters S S in Fig. 1) and enter into the bar; it is kept steady in its position when moved, by the heads of those screws being larger than will pass through the slots. V V are two drivers, of which, on the telegraph's motion, the one or the other by means of a tooth on the lower edge drives off a thumb lever from one of the catches (*b b*, Fig. 1), and lets down the falling bar to which the thumb lever so driven off is attached; 3, 4, are two horizontal pins receiving betwixt them the crank *a* of the stretching bar, (another part of the said machine hereinafter described under Fig. 6), in which position the said stretching bar is upon the motion of the said telegraph bar carried alternately backwards and forwards, so that the catches *b* and *c* in Fig. 6, may in turn enter the teeth of the circular rack at the end of each beam on which the warp is wound; and by pressing on the thumb bit at the extremity of the said crank *a*, the stitches are drawn up.

Fig. 5 represents the swing bar; this bar is attached to the bottom of the aforesaid main bar by the screw W in the centre, which passes through into the said main bar. The swing bar works on the said last-mentioned screw, and regulates the sideway movement of the machine, whilst laying the threads over the needles by its ends stopping against the inner sides of the cranks of the crank bar, it has a slotted bit represented by letter *y*, screwed on each end for its adjustment; 5 and 6 are two finger bits, by which either end of the swing bar is pushed in.

Fig. 6 represents the stretching bar, the use of which has already been described under 3 and 4 in Fig. 4; this bar is affixed by a screw passing through the slot at its end to an arm, fastened on the side piece of the wood work

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work (as represented in the perspective entire view of the said machine and frame, letter F) Q.

The making of some particular species of lace (as hereinafter mentioned) will require the following alterations to be made in the said machine; namely: that the aforesaid swing and telegraph bars be taken off, and that in their stead be substituted the rack (letter E underneath Fig. 1), which on these occasions is fixed to the aforesaid main bar on the upright pin or pivot (*e*, Fig. 1). Through the centre hole (*e*, Fig. 1.) it embraces the perpendicular pin (*g*, Fig. 2.) with its forked end *g*; and at the same time admits through the upright notch *h*, the horizontal pin (*h*, Fig. 3). By means of these two pins when turned upon its pivot, the said rack moves the two falling bars in opposite directions; the regulating screws in the aforesaid end bits being drawn back to give liberty to this motion, which is regulated in distance by the spring D, receiving into its notches *b b*, the teeth of the falling bars (*b b*, Figs. 2 and 3). This spring is screwed to the main bar at the hole *d*, Fig. 1.

Having thus described the different parts of my said new-invented machine, I now proceed to describe, specify, and explain the mode in which the same is worked, so as to produce the lace or net-work above-mentioned. The warp is wound on two beams with arbors or spindles fastened in the ends; which arbors are supported and turn on screw-points, passing through arms fixed on the side pieces of the wood-work, and entering the ends of the arbors. Two perforated bobbins are put on the arbors at one of the ends, and are kept from turning by square parts of the arbors entering into correspondent squares in the bobbins. The ends of a line are fastened to bobbins, and a weight suspended on the line to keep the threads

tight

tight between the beams and the needles; as the beams turn round by the threads feeding the needles, the line winds round the bobbins and draws up the weight, which is let down again by taking the bobbins off the squares of the arbors.

To make Brussels lace, the machine is set to a two-needle shog (a technical term for its sideway movement at the distance of two needles), the swing bar is so adjusted, that when put in at either end it stops the sideway movement half the distance it would otherwise move. The thumb levers attached to the falling bars are put under the lower stops of the catches. The threads on one beam are entered through the eyes of the guides on one falling bar, and those on the other beam through the eyes of the guides on the other falling bar, one thread from each beam enters between every pioneer. It may be necessary to remark that when the threads are much inclined to twist, there is, exclusive of the pioneers already described, another row of pioneers used which enters between the threads at the bottom of the crank bar; this row of pioneers is made of straight wires fastened in a slip of wood, which is supported by arms on the side pieces of the wood work or fixed to the crank bar; the work is set on in the same manner as in the common horizontal warp frame, and when the proper number of courses (necessary for the quality of the lace designed, namely, two for the lace now describing) are worked with the swing bar in on the right hand or floor side, the telegraph is moved, which lets down one of the falling bars so low, that the guides on it will not lay the threads over the needles; the swing bar is then pushed in on the left or window side, and the machine held to the right or floor side, and the threads laid over half of the needles

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needles which form loops on them; the swing bar is then pushed in on the right or floor side, and the machine held to the left or window side, and the threads are laid over the other half of the needles forming loops likewise on them; the whole of the loops are then brought under the needle beards, and the needles pressed, and the stitches brought over the loops; the thumb is then pressed on the thumb lever attached to the bar let down which raises it up, and the lever is turned under the lower stop of the catch. The stitches are then drawn up by pressing the thumb on the thumb bit at the extremity of the stretching bar, or they may be drawn up by turning the beam with the hand. Two more courses are then made as before, and the telegraph is moved which lets down the other falling bar, and the swing bar and machine are used in the same manner as when the first falling bar was let down; the same process is continued to the end of the piece.

To make tactic lace, the process is the same in every respect as before described to make the Brussels lace, differing only by letting down one falling bar twice in succession, and then the other twice; whereas, in making the Brussels lace the falling bars are let down alternately.

To make Valenciennes lace, the alterations are to be made in the said machine as explained under letter Q, after the description of Fig. 6; the machine is set to a one-needle shog, which is the distance of its sideway movement for laying the threads over one needle; the threads are entered through the guides and between the pioneers, in the same manner as before described for making the Brussels and tactic lace: In making this lace, the machine is always held to the left or window side,

two

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two courses being worked; the lower falling bar is then let down by the thumb turning the thumb lever from under the lower stop of the catch; the falling bars are then moved one nick each in contrary directions, by the rack which causes the threads through the guides on one falling bar to cross those on the other falling bar. The bar that was let down being raised again by pressing the thumb on the thumb lever attached to it, one course is worked laying the threads over contrary needles; the same falling bar is again let down, and the bars are moved by the rack to their former nicks, when two courses are worked the same as at the beginning; the same falling bar is then again let down, and both falling bars are moved by the racks into contrary nicks; by turning the rack the contrary way to that which crosses the threads the last time, one course is worked with the threads crossed, and the same falling bar is again let down, and the bars are moved by the rack into the nicks from which they were removed; the falling bar is then put up, and the above process is repeated to the end of the piece.

I have thus described the modes of making the three different sorts of lace above-mentioned, as the most satisfactory means of describing the nature and use of my said invention, reserving to myself the right of making such other lace or net-work as the said machine is capable of making, by varying the movements.

In witness whereof, &c.

Specification

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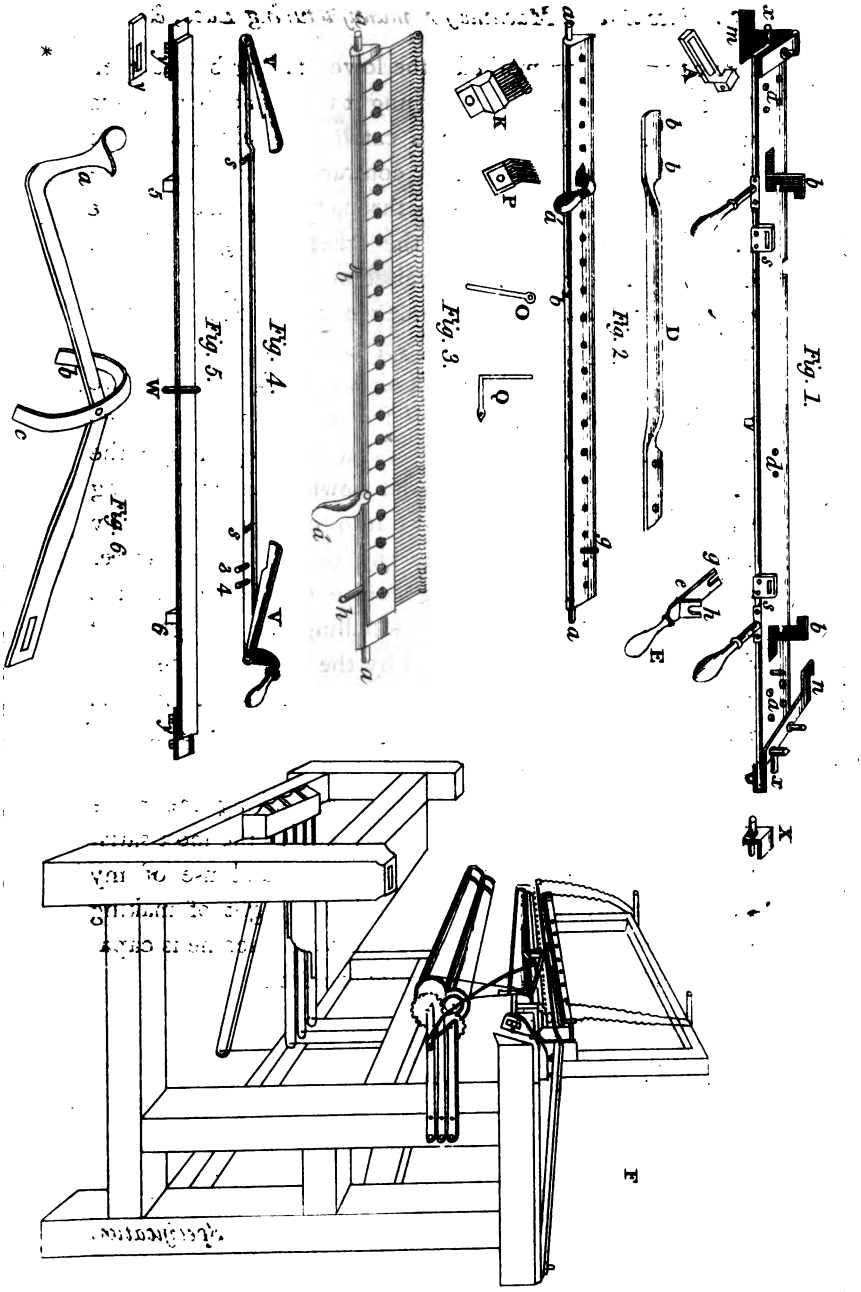

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Specification of the Patent granted to WILLIAM WARRIS, *of Sheffield, in the County of York, Optician; for an Improvement in the mounting of Glasses, commonly called Opera Glasses.* Dated August 4, 1804.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said William Warris do hereby declare, that my said invention of an improvement in the mounting of glasses, commonly called opera glasses, is fully described and ascertained as follows; that is to say: The mountings of all opera glasses of the common construction possess more or less the conical form, having one tube, spring, or drawer, raised above another, see Fig. 1, (Plate XVI.) which represents a mounting of a nine-draw opera glass, of the common construction when shut. My invention consists in making the mountings of such glasses to occupy the least, or nearly the least, possible space to which they are capable of being reduced. This I perform by reducing the tops or heads of the tubes, springs, or draws, to an horizontal plane or level surface, or nearly so, so that the same number of tubes, springs, or draws, represented in Fig. 1, may be contained within the space of the exterior case *a b c d* of that figure.

To mount a glass to occupy the least possible space, I make a groove or cavity in the head of each tube, spring, or draw, sufficiently deep to receive the next within it; the interior tube or head having a ring or other contrivance within its cavity, by which the tube may be drawn out, see section Fig. 2. But as it will be found perhaps equally convenient, and less expensive, that the head of the first or interior tube should project above the others, I

make them as represented in Fig. 3, which occupies nearly the least possible space.

I apprehend that by referring to the drawings in the margin of these presents, the nature of my invention, and the manner of carrying the same into execution, will be evident to the meanest capacity.

Fig. 1 represents a nine-draw opera glass, of the common construction, shut up.

Fig. 2 is a section of my improved opera glass with nine draws, exhibiting the manner in which the grooves are made, and the tubes, springs, or draws, connected together.

Fig. 3 represents my improvement shut up, with the head of the first or interior tube projecting.

Fig. 4 exhibits the same with the whole of the tube sunk within the exterior case.

The above-described improvement permits all the tubes to be drawn out to their full length, so as to give the greatest possible extension, whereas in those of the common construction the widest draw is as much shorter than the smallest, as the conjoint thickness of the spring heads being nearly one-third part of the opera glass, Fig. 1. From the form of the opera glasses of the common construction, the edges of the springs are very liable to be injured by wear, which inconvenience is obviated by my improvement.

It is perhaps unnecessary to mention, that glasses may be mounted according to my improvement either in gold, silver, gilt, plated, brass, or any other material of which they are at present made.

In witness whereof, &c.

Specifica

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Specification of the Patent granted to ROBERT RAINES, *the Younger, of the Town and Port of Hull, in the County of York, Tanner and Glue-manufacturer; for the making and manufacturing of hard Glue from the Tail, Fins, and other Parts of the Whale-fish.*

Dated November 22, 1804.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in pursuance of the said proviso, I, the said Robert Raines do declare, that my said invention for making and manufacturing hard glue from the tail, fins, and other parts of the whale-fish, is as follows. In preparing and manufacturing is as follows. The tail, fins, and all other gristly parts of the fish, are cut into pieces of fourteen or fifteen pounds weight. Such pieces are then put into boiling water, and kept hot by a slow fire for half an hour, in order to extract the oil and grease, that the next process may take effect. The next process is to steep the pieces of fish in fresh water forty-eight hours, and which steeping is to be repeated four times, having fresh water each time. Then take one ton of fish, thus prepared, with one hundred and twenty gallons of fresh, spring, or soft water, which boil together twelve hours in a common glue bag. Then put out the fire, and take out the bag, and let the ingredients, which will have been strained through the bag, remain in the copper half an hour. Then add twenty pounds weight of pounded alum. After mixing these ingredients well, let them remain in the copper twelve hours more, to incorporate with each other; it must then be let off into coolers, and when cool laid on nets to dry, the same as other glue: the preparation is then complete.

In witness whereof, &c.

Specification of the Patent granted to JAMES RYAN, *of Dorsane, in the Queen's County, Ireland, Engineer to the Undertakers of the Grand Canal, for sundry Tools, Implements, or Apparatus for boring the Earth for Coal, and all Kinds of Minerals and subterraneous Substances, by which the different Strata may be cut out in a cheap and expeditious Manner, in Cores or Cylinders, from one Inch to twenty Inches and upwards in Length, and from two Inches to twenty Inches and upwards in Diameter, so as to be taken up entire at any Depth that has hitherto been bored; by which, not only the Quality of such Minerals and Substances, but also the Declination or Dip of the Strata, can be ascertained beyond a Possibility of Mistake; and which Tools, Implements, or Apparatus, are also advantageously applicable to the Purpose of sinking for Wells, and giving Vent to subterraneous Water in Bogs, and draining Mines and Grounds, and ventilating Pits, and other beneficial Purposes.* Dated February 12, 1805.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said James Ryan do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, as follows; that is to say; The boring apparatus consists of two spring poles fixed as in Fig. 20, (see Plate XV.) to which is attached by two chains or cords, a rod of iron or other metal in joints, secured to each other by screws or otherwise, so that the said rod may be lengthened or shortened in the usual manner, and of sundry bits or tools for boring, to be fastened to the farther extremity of said rod, each singly contrived for penetrating that particular species of soil best

best to which it is adapted, as shall be hereafter described; and of several auxiliary implements for extracting the soil from the hole formed by the said borers, and for otherwise assisting the operation of boring as shall hereafter be fully explained herein.

The boring instrument having that bit fixed to it best suited to the soil it is intended to penetrate, and being suspended to the spring-poles, is to be put in motion by a handle or spar fastened to it at right angles, as in Fig. 20, or by a crank as in Fig. 6, as best suits the work. The use of having two spring poles is to keep the rod steady to the perpendicular line of the hole, which a single one could not do, as its motion must be performed so as to form arcs of a circle by its extremity, which must move the boring rod untrue to the work.

In Fig. 20, which represents this part of the operation, A A exhibits the spring poles; B B the fulcrums or supports on which the said poles rest; F F, the chains by which the rod is attached to the poles; E E, the handle by which the boring rod is worked; D, the boring rod; and C, the hole or excavation formed by boring. The spring poles A A, are each to be about thirty feet long, and are to be placed so as to work within about two inches of each other, where the chains are fastened to them.

As the soil to be bored is of various consistencies in different places, and at different depths oftentimes in the same place, I have contrived various bits to be attached to the boring rod according to the soil to be bored, which are as follows, and which I shall now describe in their order; first, a boring bit for boring earth; second, a bit for boring stiff clay or shale; third, a bit contrived for penetrating hard and solid rock; fourth, a bit for boring shale and stone; and fifth, a bit for boring earth, clay,

clay, or gravel, &c. when mixed with water, and which I shall denominate a puddle bit.

1. The bit for boring earth is represented in Fig. 1. It consists of a hollow cylinder A of iron, terminating in a conical part D, at whose extremity is a kind of chissel or cutter C; in the side of the conical part is contrived a valve opening inwards, represented at E, it has a screw B at its upper part by which it is attached to the boring rod when used, beneath which appears the method by which the part of the rod fixed to it is fastened to the cylinder. In Fig. 2 is represented the transverse section of this instrument, to shew more fully the construction of the valve; in this, E represents the valve; F, a spring to keep it gently pressed forward, but which will yield so as to admit a small stone occasionally; D is the cylinder.

2. The bit for boring clay or shale is shewn in Fig. 3. It consists of four cutters A A A A, attached to the rod B, and inclining in chissel-shaped points, this cuts out a circular groove or channel, leaving a core of clay within it, which is removed by a sort of tongs contrived for this purpose, represented in Figs. 9 and 11. In these, D shews the head of the tongs, to be connected with the boring rod when wanted; B B, two short arms which connect the handles of the tongs with the part D, by joints similar to those used in a joiner's rule; E, a sliding part which moves on a button or pin in the part C, which part C is formed similarly to the part B; F F are the claws of the tongs, formed of oblong sections of a cylinder to hold the core formed by this bit the more firmly; they are also serrated at their extremities.

Figs. 10 and 12, represent more at large the short arms B in the two positions, when open and when shut. To use these tongs, the part D must be depressed, the

tongs

tongs assume the same position as in Fig. 9; they are then to be lowered on the core, which when drawn up they will hold firmly, by the action of the arms B tending to close the tongs the more, the greater the weight is which may be attached to the claws F F. Fig. 11, shews the tongs when surrounding a core and ready to draw it upwards. Fig. 4, shews the horizontal section of the core B, and of the channel C cut by the chissel or cutters A of the bit, Fig. 3.

3. The bit for boring hard rock consists of two hollow iron cylinders, one a little larger than the other and placed outside it; lead is then run into the space between them, so as to fill it all except the part B, Fig. 6; from the cylinders rise two upright parts C C, which connect them with the boring rod to which is attached the crank G, by which a circular motion is communicated to the bit; D, is a box containing water and sand, which falls into the vacant space B through the pipe E, in which pipe are three small wires connected with a float F in the box D; when the bit is worked round, the float will also acquire motion, by which the sand and water will be made to pass freely through the pipe by the wire attached to the float. This instrument works like a stone cutter's saw, and may be therefore also called a *circular saw*. One made on this construction on a small scale might be useful for the stone masons and statuaries in boring stone and marble, and also for boring rock for blasting, for all which uses I claim the patent right to it.

The instrument, Fig. 8, is used in taking up the mud, formed by the working of the above tool, from the circular channel; it consists of two hollow cylinders similar to those described in the last boring bit, and fixed to the boring rod in the same manner; the space between the two cylinders is left vacant to receive the mud; the bot-

tom

tom of this vacancy is closed up all except the space D, in which is placed a valve, opening inwards, to admit the mud, and a scraper C to take it up Fig. 7, is the horizontal section or face of the saw. The core formed by this bit is to be extracted by the tongs, Fig. 9, already described.

4. The bit for boring shale and stone consists of a circular rim, to which is attached any convenient number of teeth or chissels, the rim is connected with the boring rod by the upright pieces as in Fig. 5, and in the manner there shewn. This bit is intended for boring soil of an intermediate nature between those kinds for which the preceding bits are formed. When it forms a core, it may be extracted by the before-mentioned tongs.

5. The puddle bit intended for boring soil mixed with water consists of a hollow cylinder, Fig. 13, connected with the boring rod as represented in the figure, its lower extremity is formed with a sort of bit for cutting and taking up the soil; above this a valve is placed, which is more fully drawn in D, Fig. 14; in both figures C shews the open space for admitting the soil. This instrument may be also used as an attendant on the others, to take up the rubbish loosened by them in situations where water is met with. The valve D is constructed so as to rise when the instrument is put down into the work, and to close when it is drawn up, by which the puddle to be brought up is retained in the hollow cylinder B.

The auxiliary implements not already described are as follows:

1. Two solid cylinders for forcing down clay into the boring hole, when a running sand is met with in boring. Fig. A, 15, is used to press down some clay thrown into the hole, by which it is forced into the fissures between the strata, and forms a solid coating to the bore-hole by the

Fig. 1.

Fig. 2.

Fig. 3.

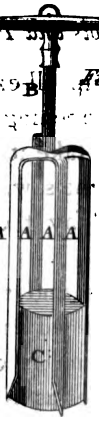


Fig. 4.

Fig. 5.

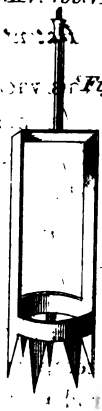


Fig. 7.

Fig. 6.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

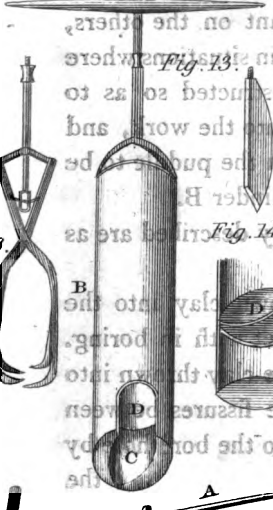


Fig. 14.

Fig. 15.

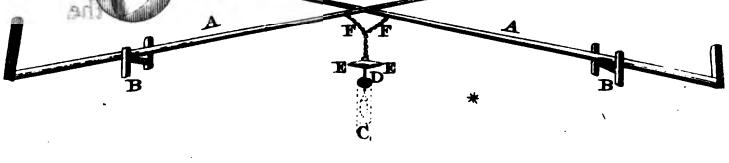
Fig. 16.

Fig. 17.

Fig. 18.

Fig. 19.

Fig. 20.



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the clay adhering to the sand. Fig. B, 15, represents another solid cylinder, for the same purpose, with a conical termination: this when put in motion circularly, after throwing some good clay into the bore hole in small quantities, will purge it, and consolidate the sides of the hole, and prevent sand from running into it.

2. An instrument to catch and support the boring rods when drawn up to be unscrewed, &c. This consists of an iron plate A, Fig. 17, attached to a platform of wood, having a hole in its centre, to admit the boring rod, which is to be placed over the boring hole; and of a moveable plate B, with a notch in it to catch and support the rods when required to be drawn up.

3. A pair of tongs, for taking up out of the boring hole any part of the rods or other matter that may have got into the said hole by accident or otherwise. These are represented sufficiently in Fig. 18.

4. A chissel for separating the cores, formed by the bits, from the substance to which they are attached. This is fully explained by Fig. 19.

5. An anvil for forming the boring rods. This is represented by Fig. 16, where A shews the body of the anvil; B its face; *c c c*, circular holes to pass the rods through when the screws are to be formed on them; *d d d*, semicylindrical cavities to form the box and pin-ends of the rods on.

The boring bits may be made of various sizes, according to the work to be performed; they may be used in boring for coals, and all minerals, and subteraneous substances, and in sinking wells, giving vent to subterraneous water in bogs, marshes, or elsewhere, in draining mines and land, in ventilating pits, mines, &c. and for other beneficial purposes.

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By some of these tools cores or solid cylinders of the soil may be extracted, from one to twenty inches in length, and from two to twenty inches in diameter, by which the dip of the different strata met with in boring may be ascertained, as well as the nature of minerals and other substances, which occur.

And by the whole apparatus described, the work of boring may be, in my opinion, performed in a more cheap and expeditious manner than by any hitherto used; and altogether it forms a set of instruments compleat, and universally applicable to every species of boring.

In witness whereof, &c.

A new Method of ascertaining the Tonnage of Ships, founded on Hydrostatick Principles; with some Account of various other Methods which have hitherto been proposed for the same Purpose. By Mr. J. W. Boswell.

Communicated by the Inventor in a Letter to the Editors.

Gentlemen,

THE common method of ascertaining the tonnage of a ship is to multiply the length of the keel (estimated in a particular manner) by the extreme breadth, and again to multiply the product by half the extreme breadth (in place of the depth); the sum thus found is then divided by 94, and the result is set down as the ship's tonnage.

Besides the inaccuracy of this method (which is now generally acknowledged), it is also injurious in tending to produce vessels of a bad form for sailing; for as both the price which is paid for a ship, together with certain duties, and other charges, depend on the measured tonnage, the merchant thinks it his interest to have the ship formed

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formed in that manner which will cause it to carry most burthen over and above the measurement; hence his vessel will be deeper and shorter than she ought to be, and also be made too full aft, which will cause her to sail heavily and steer badly, and to roll and pitch with great violence. In consequence of which the sails and rigging will be soon worn out, the hull itself want frequent calking and repairs from the straining it must undergo, the masts often be sprung or lost, and the danger in war time of capture from parting convoy be extremely increased.

These and similar considerations have induced gentlemen to propose other methods of estimating tonnage; some by a different mode of measurement (of which I believe that of Admiral Chapman is esteemed the best,) some by mechanical methods, which I will here detail; and one nobleman by forming the vessel entirely according to regular geometrical curves in its different sections.

The mechanical methods proposed for determining the tonnage of vessels are as follows. By one it was directed to take the ship into a dock shaped as a regular parallelopiped, which should have a reservoir annexed to it capable of holding the exact contents of the dock when filled to a certain height, marked on its side; then after drawing off all the water which floated the ship into the dock, and closing the gates carefully, to pump into it all the water contained in the reservoir. After these opetions the weight of the ship, either full or empty, (and of course her tonnage,) was to be ascertained by the height to which the water should rise in the dock above the marked line.

Another method proposed was to form a large floating machine, or cassoon, having a flat bottom and upright sides, with gates at one end (to admit the vessel to be

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weighed,) from which all the water was to be pumped out after the vessel was admitted; and the weight of the vessel and her cargo to be then computed by the depth to which this cassoon was immerged, more than its draught when empty.

Both these methods would not only be extremely expensive in the preparation of apparatus, but also attended with much difficulty in making that apparatus perfectly staunch so as to admit or lose no water; and moreover with much labour and expense in the pumping necessary for the trial of each vessel.

A third method proposed, was to form an exact model of the ship to be measured on a small scale, and to find the burden of this model by putting it into a cistern of water regularly shaped, and marking the height to which the water rose in the cistern on loading the model to its different lines, and then multiplying the burden of the model by the difference of the scales of it and the large ship.

This method would also be attended with considerable expense, and would be liable to great inaccuracy, from the certainty of every error in the construction of the model, and in the computation being multiplied in the extensive ratio of the difference between its size and that of the ship.

A fourth method directs to fill the ship with water to the load-water line (first taking care that she is perfectly staunch), and then to pump out the water into vessels, each containing a certain proportion of a ton.

A fifth method is that which is practised for ascertaining the tonnage of boats on some canals, which is, to load the vessel with a cargo, each part of which has been previously weighed, or with actual weights.

The objection to these two last methods is the expense and labour in performing the operations necessary therein,

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therein, which would be very considerable for large vessels.

All these methods recited being either inaccurate, very expensive, or inapplicable to large ships, leaves the subject still open for discussion; I shall beg leave therefore to propose another way of determining the tonnage of ships, which appears to me not to be liable to the same objections, and which I am the more inclined to hope may be of use, as it is now near two years since I first thought of it, during which time I have frequently re-examined it, and have not yet been able to perceive any material obstacle to its being adopted.

This method is founded on principles of hydrostaticks similar to those used for ascertaining the specific gravity of different bodies, and the basis of it is the different weight which the same body will exhibit in two fluids of different density.

Sea water is known to exceed fresh water so much in weight that many bodies which will float in the first will sink in the latter: this difference is usually computed as that between 1037 and 1000, which is equal to a twenty-seventh (within a minute fraction) in favour of the sea water.

This is the foundation on which I proceed; and as there is nothing in nature more certain than the above fact, the fair conclusions which are drawn from it cannot but take place.

There are two methods by which ships may be weighed, or their tonnage ascertained, on these principles, which merely depend on which of the two fluids they are first examined in: both shall be here inserted.

If it happens to be most convenient to examine the ship first in the salt water, let a calm day be chosen for the purpose, when the water is smooth; then let the draught of water be carefully marked on the stem and stern-post,

by

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by driving in a spike or other pointed instrument at the exact line to which the water rises in each place: after this float the vessel into fresh water, on which her draught will be encreased, and the marks be covered more or fewer inches, in proportion to the depth of the vessel. Then take out part of the cargo of the ship, either into a lighter or on shore, which will cause the vessel to rise again; and when enough is taken out to bring the marks to a level with the surface of the water, then weigh the part of the cargo taken out (which, as it will not exceed between 3 or 4 *per cent.* of the weight of the whole cargo, can occasion no great trouble); after this ascertain the difference of the specific gravity of the salt and fresh water by carefully weighing the same measure full of each in accurate scales, if it has not been done previously.

You will by these operations determine the actual weight of the difference of the gravity of the ship in fresh and in salt water, and also the proportion which this difference bears to the whole weight of the ship, from whence you may find the weight of the cargo by the following calculation.

Divide the weight of the measure of fresh water by the difference of the gravity of it, and that of the same measure of salt-water; and by the quotient of this multiply the weight of the part of the cargo taken out: the result will produce the weight of the whole ship and cargo.

From this you may find the weight of the cargo, by deducting from the whole weight so found the weight of the ship when empty, which may be ascertained in same manner as above directed after the whole cargo is taken out; and this will give the tonnage of the ship, if she was loaded to her load-water-line as she should be.

This method may be made more clear by the following example: suppose the measure in which the water is weighed holds 1000 ounces of fresh water, and that the same

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same measure will contain 1037 ounces of salt water; and suppose that the part of the cargo removed from the ship (to bring it in the fresh water, to the same level as in the salt water) was found to be ten tons.

Then divide 1000 (the weight of the fresh water) by 37, (the difference of the gravity of the fresh and salt water); this will produce $27\frac{1}{37}$, which multiply by ten tons (the weight of the removed part of the cargo), and you will have $270\frac{10}{37}$ tons for the weight of the whole ship and cargo: from which deduct the weight of the ship when empty (which suppose was found to be $70\frac{10}{37}$ tons), and the remainder 200 tons will be the tonnage of the ship. The proof of the foregoing depends on the well-known fact in hydrostaticks, that a floating body displaces a portion of fluid equal to its own weight; and that having the proportional difference between two sums, you may from it find the value of either; which truth is too well known to need proof, at least in this publication.

The second method of ascertaining the tonnage, to be used when the ship is examined first in fresh water, is in some degree the reverse of the former, and is as follows:

The draft of the ship in the fresh water is to be marked on it, as before directed, and the ship then floated into salt water; which will cause the marks to rise more or less above the level of the water; additional loading is then to be put into the ship, until she is depressed to the former level, as will be shewn by the marks. The additional loading is then to be weighed, the difference of the gravity of the fresh and salt water ascertained, and the calculation made as before-mentioned.

The difficulty of finding the exact draft of the vessel, if there should be any roughness in the water, may be obviated by having a small bent tube passed through a trenel hole below water mark, as near the middle of the ship as possible, and made tight outside by a small can-

vas

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vas case stuffed at its extremity, in manner similar to that contrived by Mr. Duncan for stoping shot holes. The upright part of the tube should rise a foot or eighteen inches above the level of the water; and a small float supporting a light index being put into the tube will shew the water level very little, if at all, affected by any moderate roughness of the water: in using this instrument, the only caution necessary is, that the deck be kept level across-ship at each time of inspection.

As the difference of the line of flotation in fresh and salt-water will be near a 27th of the whole draft of water, it will be sufficiently conspicuous, in as much as it will be from 4 to 6 inches in vessels of 14 feet draft, and more in proportion in those of greater depth; but should it be desired to make this more apparent, it may easily be effected, by using a sloping glass tube for the upper part of the instrument before-mentioned, in which every degree that the water rises or falls will appear increased in proportion to its angle of inclination; to prevent accidents, the glass tube may be set in a wooden or copper case, leaving only a portion of the front exposed, through which the height of the water may be seen.

Though in the case recited I have supposed one of the two sorts of water, in which the ship was to be examined, to be quite fresh; yet this is not absolutely necessary, though the nearer it is so the better; from this it follows, that there are very few rivers of any note communicating with the ocean, which do not afford situations in which the tonnage of ships might be ascertained in this manner; the best and most convenient place for doing this, however, is where there is a floating dock, near the sea, which either is, or can occasionally be, filled with fresh water.

It may not be amiss to mention, though it is an obvious caution, that the ship should be made as staunch as possible

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possible before her tonnage is determined in this manner: and that, if a little water leaked in, it should be carefully pumped out at the time of taking the draft of the ship in each kind of water.

It would be most convenient to have the part of the cargo, which is required to be shifted in this method, to consist of iron ballast; and, next to this, casks full of water of equal size would be moved with least trouble; and if this method should ever come into use in any of the many places, where there are now even docks constructed, in which part of the operation might be performed, it would be expedient to have in such places a few tons of iron ballast, of which each piece should be cast of the same weight; which would much facilitate the computation of the weight of the part of the cargo to be shifted, if it was used in this part of the business, which is the only part of it attended with any trouble; but in any case, the shifting and weighing a few tons of ballast would be no great operation, and at least would be attended with infinitely less difficulty or expense than any of the mechanical modes proposed for effecting the same purpose; and at the same time possesses more accuracy than most of the methods of measurement hitherto practised.

If the ship was either to receive or deliver her loading in a fresh water dock, the whole operation of weighing her both empty and full might be performed without her having occasion to go into the dock more than once; only with this difference, that, if she received her loading there, her weight when empty should be first ascertained; and if she went in full, then her weight when empty should be determined after the amount of the weight of the ship and cargo was taken together.

Yours, &c.

J. W. Boswell.

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Description of an improved Sheepfold. Invented by THOMAS PLOWMAN, *Esquire, of Broome, in Norfolk.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Gold Medal was presented to Mr. PLOWMAN *for this Invention.*

THE sheepfold invented by me is on an improved and very simple principle, combining many advantages over the old and expensive method of folding by hurdles: and as the whole fold can be removed with ease at all times, it will be found peculiarly useful in feeding off turnips on the land in frosty weather, when hurdles cannot be used; and, as the saving of labour in agriculture is a leading object, I have no doubt of seeing it in a very few years generally adopted.

The expense in the first instance will exceed that of hurdles for the same given quantity of sheep; but having had one in use nearly three years, I am satisfied the saving will be very considerable; for, before I adopted this method of folding, I lost from thirty to forty nights folding in the year, owing to the land being hard in dry seasons, which renders folding almost impracticable, as they never can be set without great labour and destruction of hurdles. I am also clearly of opinion, that the stock of sheep will be greatly increased when this method of folding becomes more known; and that it will enable many small farmers to keep from fifty to one hundred sheep, who are now deterred from it on account of the small quantity of feed they have not answering to keep a man

man for that purpose only; but by this plan they may keep a boy at three shillings or three shillings and sixpence *per* week, who can attend on one hundred or two hundred sheep, and move the fold himself without any assistance. In heavy gales of wind it frequently happens that hurdles are blown down, and the sheep of course being at liberty to range over the crops do incalculable mischief, which cannot happen with my fold.

In some counties in Egland, where hogs are folded; great difficulties are experienced for want of stowage for them to feed off winter tares, &c. &c. as they root up every stake or hurdle; and, having tried the experiment, I am certain my fold will keep them in, and defy their attempt to displace it.

One man can remove a fold to contain three hundred sheep in five minutes, which by the old method frequently takes some hours to accomplish.

REFERENCES to the ENGRAVING, Plate XVI.

Fig. 5, twenty-one feet long and three feet eleven inches high, composed of a top rail A, three inches deep and two inches thick.

B, the upper bar, three inches deep and three quarters of an inch thick.

C C, the two lower bars, four inches by three quarters of an inch, which, with the upper bar, are mortised through the uprights D D D D, which uprights are oak, three inches by two inches.

E, the lower bar, three inches by three.

F, an upright bar, with the horizontal bars halved into it.

G G, two oak uprights, three by two inches.

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Fig. 6 shews the oak uprights G G.

H, the axletree, three inches by three, and three feet between the wheels.

I, an oak knee, which connects the uprights G G with the axletree by means of two screws and nuts.

Fig. 7 a plan in which the axle H is shewn with two arms K K at right angles to H, which are made to act as pivots to the wheels when intended to be moved in a direction at right angles to the bars.

Fig. 8 is a view of the same parts described in Fig. 7.

The wheels marked W in all the figures are of cast-iron, and cost three shillings and sixpence each.

Where the fold is wanted to be used in very hilly ground you must begin at the top, and work it down to the bottom, for the ease of removing it, and then draw it up again with a horse. This, however, I have never had occasion to do; for the land with us is ploughed in a contrary direction, and we work the fold in the same course as the ridges. By this means the inconvenience is avoided of crossing the furrows, and they are also a guide to keep the fold in a straight direction.

With respect to the sheep getting under, I do not recollect that circumsfance to have happened, nor do I conceive that any land which is cultivated can be so uneven as to admit of it.

Satisfactory certificates accompanied the above account from gentlemen who are now using the sheepfolds; stating that they fully answer the purpose intended, and that the invention is a very valuable improvement.

Analytical

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Analytical Experiments and Observations on Lac,

By CHARLES HATCHETT, *Esq. F. R. S.*

(Concluded from Page 277.)

§. *Analytical Experiments on Stick, Seed, and Shell Lac.*

LAC, when placed on a red-hot iron, at first contracts, and then melts, emitting a thick smoke, of a peculiar but rather pleasant odour; after which, a light spongy coal remains.

Distillation of Stick Lac.

100 grains of the best stick lac, separated as much as possible from the twigs, were put into a glass retort, to which a double tubulated receiver and hydro-pneumatic apparatus were adapted. Distillation was then gradually performed with an open fire, until the bottom of the retort became red-hot.

The products thus obtained were,

	Grs.
1. Water slightly acid	10.
2. Thick brown butyraceous oil	59.
3. Spongy coal	13.50
4. A small portion of carbonate of ammonia, with a mixture of carbonic acid, carbonated hydrogen, and hydrogen gas, which may be estimated at	17.50
	100.

Seed Lac.

100 grains of very pure seed lac were distilled in a similar manner, and afforded,

1. Acidu-

	Grs.
1. Acidulated water - - - - - - - - - -	6.
2. Butyraceous oil - - - - - - - - - -	61.
3. Spongy coal - - - - - - - - - - -	7.
4. Mixed gas nearly as before, but without ammonia, amounting by estimation to - -	26.
	100.

Shell Lac.

100 grains of shell lac, treated as above, yielded,	Grs.
1. Acidulated water - - - - - - - - - -	6.
2. Butyraceous oil - - - - - - - - - -	65.
3. Spongy coal - - - - - - - - - - -	7.50
4. Mixed gas, amounting by estimation to -	21.50
	100.

The coal of the shell lac, by incineration, afforded about one grain of ashes, which contained a muriate, probably of soda, and a little iron, with some particles of sand, which may be regarded as extraneous.

Analysis of Stick Lac.

A. 200 grains of stick lac, picked and reduced to powder, were digested in a pint and a half of boiling distilled water during twelve hours. The liquor was transparent, and of a beautiful deep red; this was decanted into another vessel; and the operation was repeated, with fresh portions of water, until it ceased to be tinged; the lac then appeared of a pale yellowish-brown colour.

The whole of the aqueous solution being evaporated, left a deep red substance, which possessed the general properties of vegetable extract, and weighed 18 grains.

B. The dried lac was digested for forty-eight hours, without heat, in eighteen ounces of alcohol; and the clear

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clear tincture being cautiously decanted, different portions of alcohol were added, and the digestion was repeated until the alcohol ceased to produce any effect.

The whole of the solutions in alcohol were then poured into distilled water, which was heated, and an attempt was made to separate the precipitated substance by filtration; but as this did not succeed, on account of the filter speedily becoming clogged, the whole was subjected to gentle distillation; by which a brownish-yellow resin was obtained, amounting in weight to 136 grains.

C. The remainder of the lac was again digested in boiling distilled water; by which two grains of the colouring extract were obtained.

D. The residuum was then digested with one ounce of muriatic acid diluted with two ounces of water, which, by boiling, became of a bright pale red, but changed to purple, when saturated with a solution of carbonate of potash.

A flocculent precipitate was thus obtained, which possessed the characters of precipitated vegetable gluten combined with some of the colouring extract; this, when completely dried, weighed 11 grains.

E. There now remained 25 grains, which evidently consisted of a sort of wax, mixed with small parts of twigs and other extraneous substances.

A part of the wax was separated by heat and pressure in a piece of linen; and another portion was separated by digestion in olive oil, which assumed the consistency of an unguent.

The residuum was then boiled with lixivium of potash, and became tinged with purple, in consequence of some of the colouring extract which had not been dissolved by the preceding operations.

The

The undissolved part, now consisting only of the extraneous vegetable and other substances, weighed 13 grains; so that the wax, with a small portion of the colouring extract, may be estimated at 12 grains.

By the above process, 200 grains of stick lac afforded,

		Grs.
A. C.	Colouring extract	18 2 — 20
B.	Resin	136
D.	Vegetable gluten	11
E.	Wax, with a little colouring extract, about	12
	Extraneous substances	13
		192.

Analysis of Seed Lac.

200 grains of very pure seed lac were subjected to operations very similar to those which have been described, and afforded,

	Grs.
Colouring extract	5
Resin	177
Vegetable gluten	4
Wax	9
	195.

Analysis of Shell Lac.

A. 500 grains of this substance were first treated with boiling distilled water, as above mentioned, and yielded of extract only 2.50 grains.

B. The 497.50 grains which remained, were then digested with different portions of cold alcohol, until this ceased to produce any effect; the resin which was thus separated, amounted to 403.50 grains.

C.

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C. As the shell lac had not been reduced into powder, but only into small fragments, these were become white and elastic, and, when dry, were brittle, and of a pale brown colour; the whole then weighed 94 grains.

D. These 94 grains were digested in diluted muriatic acid; and the acid, being afterwards saturated with solution of carbonate of potash, afforded a flocculent precipitate, (resembling that obtained from solutions of vegetable gluten,) which, when dry, weighed 5 grains.

E. Alcohol acted but feebly on the residuum; it was therefore put into a matrass, with three ounces of acetic acid, and was suffered to digest without heat during six days, the vessel being at times gently shaken; the acid thus assumed a pale brown colour, and was very turbid. The whole was then added to half a pint of alcohol, and was digested in a sand-bath; by which a brownish tincture was formed, and at the same time a quantity of a whitish flocculent substance was deposited, which, being collected, well washed with alcohol on a filter, and dried, weighed 20 grains.

This substance was white, light, and flaky, and, when rubbed by the nail, it became glossy, like wax; it also easily melted, was absorbed by heated paper, and, when placed on a coal or hot iron, emitted a smoke, the odour of which very much resembled that of wax, or rather spermaceti.

F. The solution formed by acetic acid and alcohol, being filtrated, was poured into distilled water, which immediately became milky; and, being heated, the greater part of the resin which had been dissolved assumed a curdy form, and was partly separated by a filter, and partly by distilling off the liquor; this portion of resin amounted to 51 grains.

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G. The filtrated liquor, from which this resin had been separated, was saturated with a solution of carbonate of potash; and, being heated, a second precipitate of gluten was obtained, which, when well dried, weighed 9 grains.

The 500 grains of shell lac thus yielded,

		Grs.
A.	Extract	2.50
B. F.	Resin	454.50
D. G.	Vegetable gluten	14.
E.	Wax	20.
		491.

The mode of analysis adopted for the shell lac must undoubtedly appear less simple than that which was employed for seed and stick lac; but, upon the whole, it was attended with advantages; for the shell lac being in small fragments, and not in the state of a powder, considerably facilitated the decantation of the solution in alcohol from the residuum; and although, in this last, a portion of the resin was protected from the action of the alcohol, by being enveloped in the gluten and wax, yet, by the assistance of acetic acid, the remainder of the resin, as well as the whole of the gluten, were dissolved; the wax was obtained in a pure state; and a separation of the resin from the gluten was afterwards easily effected, by the method which has been described. As therefore acetic acid is capable of dissolving resin, gluten, and many other of the vegetable principles, it certainly may be regarded as a very useful solvent in the analysis of bodies appertaining to the vegetable kingdom.

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From the results of the preceding analyses it appears, that the different kinds of lac consist of four substances, namely, extract, resin, gluten, and wax, the separate properties of which shall now be more fully considered.

Properties of the colouring Extract of Lac.

1. When dry it is of a deep red colour, approaching to purplish crimson.

2. Being put on a red-hot iron, it emits much smoke, with a smell somewhat resembling burned animal matter, and leaves a very bulky and porous coal.

3. Water, when digested with it in a boiling heat, partially dissolves it; but the residuum was found to be absolutely insoluble in water.

4. Alcohol acts but slowly on it; and, in a digesting heat, dissolves less than water. The colour of the solution is also not so beautiful; and a considerable part of the residuum left by alcohol was, when digested with water, found to be soluble, although this was not the case, when the residuum left by water was treated with alcohol.

5. It is insoluble in sulphuric ether, excepting a very small portion of resin, which appeared to be accidentally mixed with it.

6. Sulphuric acid readily dissolves it, and forms a deep brownish-red solution, which, being diluted with water, and saturated with potash, soda, or ammonia, becomes changed to a deep reddish-purple.

7. Muriatic acid dissolves only a part: the solution is of the colour of port wine, and by the alkalis is changed to a deep reddish-purple.

8. Nitric acid speedily dissolves it: the solution is yellow, and rather turbid; but the red colour is not restored by the alkalis, for these only deepen the yellow

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colour. This nitric solution did not afford any trace of oxalic acid.

9. Acetic acid dissolves it with great ease, and forms a deep brownish-red solution.

10. Acetous acid does not dissolve it quite so readily, but the solution is of a brighter red. Both of the above, when saturated with alkalis, are changed to a deep reddish-purple.

11. The lixivia of potash, soda, and ammonia, act powerfully on this substance, and almost immediately form perfect solutions, of a beautiful deep purple colour.

12. Pure alumina, put into the aqueous solution, does not immediately produce any effect; but, upon the addition of a few drops of muriatic acid, the colouring matter speedily combines with the alumine, and a beautiful lake is formed.

13. Muriate of tin produces a fine crimson precipitate when added to the aqueous solution.

14. A similar-coloured precipitate is also formed by the addition of solution of isinglass.

These properties of the colouring substance of lac, especially its partial solubility in water and in alcohol, and its insolubility in ether, together with the precipitates formed by alumina and muriate of tin, indicate that this substance is vegetable extract, perhaps slightly animalized by the coccus.

The effects which it produced on gelatin also demonstrate the presence of tannin; but this very probably was afforded by the small portions of vegetable bodies, from which the stick lac can seldom be completely separated.

Properties of the Resin of Lac.

This substance is of a brownish-yellow colour; and, when put on a red-hot iron, it emits much smoke, with a peculiar sweet odour, and leaves a spongy coal.

It

It is completely soluble in alcohol, ether, acetic acid, nitric acid, and the lixivia of potash and soda.

Water precipitates it from alcohol, ether, acetic acid, and partially from nitric acid; and it possesses the other general characters of a true resin.

Properties of the Gluten of Lac.

It has been already observed, that when small pieces of shell lac have been repeatedly digested in cold alcohol, they become white, bulky, and elastic. By drying, these pieces become brownish and brittle; the elasticity is also destroyed by boiling water exactly as when the gluten of wheat is thus treated.

If the pieces of shell lac, after the digestion in alcohol, be digested with diluted muriatic acid, or with acetic acid, the greater part of the gluten is dissolved, and may be precipitated, in a white flaky state, by alkalis; but if these last be added to excess, and heat be applied, then the glutinous substance is redissolved, and may be precipitated by acids.

If the pieces of shell lac, after digestion in alcohol, be treated with alkaline lixivia, then the whole is dissolved, and forms a turbid solution. But when acids are employed, the chief part of the gluten is alone acted upon, and a considerable residuum is left, consisting of the wax, some of the resin, and a portion of gluten, which has been protected from the action of the acid by the two former substances.

The above properties indicate a great resemblance between this substance and the gluten of wheat; I therefore have called it gluten, but, at a future time, I intend to subject it to a more accurate examination.

Properties

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Properties of the Wax of Lac.

If shell lac be long and repeatedly digested in boiling nitric acid, the whole is dissolved, excepting the wax, which floats on the surface of the liquor like oil, and when cold may be collected; or it may be more easily obtained in a pure state, by digesting the residuum left by alcohol in boiling nitric acid.

The wax thus obtained, when pure, is pale yellowish white, and (unlike bees wax) is devoid of tenacity, and is extremely brittle.

It melts at a much lower temperature than that of boiling water, burns with a bright flame, and emits an odour somewhat resembling that of spermaceti.

Water does not act upon it, neither does cold alcohol; but this last, when boiled, partially dissolves it, and, upon cooling, deposits the greater part; a small portion however remains in solution, and may be precipitated by water.

Sulphuric ether, when heated, also dissolves it; but, upon cooling, nearly the whole is deposited.

Lixivium of potash, when boiled with the wax, forms a milky solution; but the chief part of the wax floats on the surface, in the state of white flocculi, and appears to be converted into a soap of difficult solubility; it is no longer inflammable, and, with water, forms a turbid solution, from which, as well as from the solution in potash, the wax may be precipitated by acids.

Ammonia, when heated, also dissolves a small portion of the wax, and forms a solution very similar to the former.

Nitric and muriatic acids do not seem to act upon the wax; the effects of sulphuric acid have not been examined.

When

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When the properties of this substance are compared with those of bees wax, a difference will be perceived; and, on the contrary, the most striking analogy is evident, between the wax of lac and the myrtle wax which is obtained from the Myrica cerifera.

An Account of the latter substance has been published by Dr. Bostock, of Liverpool, in Nicholson's Journal, with comparative Experiments and Observations on Bees Wax, Spermaceti, Adipocire, and the crystalline Matter of biliary Calculi *.

The properties of the myrtle wax, as described in Dr. Bostock's valuable Paper, so perfectly coincide with those which I have observed in the wax of lac, that I cannot but consider them as almost the same substance; indeed I think they may be regarded as absolutely identical, if some allowance be made for the slight modifications which have been produced by the different mode of their formation.

From the preceding experiments and analyses we find, that the varieties of lac consists of the four substances which have been described, namely, extractive colouring matter, resin, gluten, and a peculiar kind of wax. Resin is the predominant substance; but this, as well as the other ingredients, is liable, in a certain degree, to variation in respect to quantity.

According to the analyses which have been described, one hundred parts of each variety of lac yielded as follows.

* Nicholson's Journal for March, 1803, page 129.

Stick

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Stick Lac.

	Grs.
Resin	68.
Colouring extract	10.
Wax	6.
Gluten	5.50
Extraneous substances	6.50
	96.0

Seed Lac.

	Grs.
Resin	88.50
Colouring extract	2.50
Wax	4.50
Gluten	2.
	97.50

Shell Lac.

	Grs.
Resin	90.00
Colouring extract	0.50
Wax	4.
Gluten	2.80
	98.20.

The proportions of the substances which compose the varieties of lac must however be subject to very considerable variations; and we ought therefore only to consider these analyses in a general point of view. Hence we should state, that lac consists principally of resin, mixed with certain proportions of a peculiar kind of wax, of gluten, and of colouring extract.

The relative quantity of the two latter ingredients very considerably affect the characters of the lacs; for instance,

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instance, we may observe, that the glutinous substance, when present in shell lac in a more than usual proportion, probably produces the defect observed in some kinds of sealing wax, which, when heated and burned, become blackened by particles of coal; for the gluten affords much of this substance, and does not melt, like the resin and wax. From what has been stated, therefore, lac may be denominated a *cero-resin*, mixed with gluten and colouring extract.

§ III. *General Remarks.*

From the whole of the experiments which have been related, it appears, that although lac is indisputably the production of insects, yet it possesses few of the characters of animal substances; and that the greater part of its aggregate properties, as well as of its component ingredients, are such as more immediately appertain to vegetable bodies.

Lac, or gum lac, as it is popularly but improperly called, is certainly a very useful substance; and the natives of India furnish full proofs of this, by the many purposes to which they apply it.

According to Mr. Kerr, it is made by them into rings, beads, and other female ornaments.

When formed into sealing-wax, it is employed as a japan, and is likewise manufactured into different coloured varnishes.

The colouring part is formed into lakes for painters: a sort of Spanish wool for the ladies is also prepared with it; and, as a dying material, it is in very general use.

The resinous part is even employed to form grindstones, by melting it, and mixing with it about three parts of sand. For making polishing grindstones, the

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sand is sifted throogh fine muslin; but those which are employed by the lapidaries, are formed with powder of corundum, called by them Corune *.

But, in addition to all the above uses to which it is applied in India, as well as to those which cause it to be in request in Europe, Mr. Wilkins's Hindû ink occupies a conspicuous place, not merely on account of its use as an ink, but because it teaches us to prepare an aqueous solution of lac, which probably will be found of very extensive utility.

This solution of lac in water may be advantageously employed as a sort of varnish, which is equal in durability, and other qualities, to those prepared with alcohol; whilst, by the saving of this liquid, it is infinitely cheaper.

I do not mean however to assert that it will answer equally well in all cases, but only that it may be employed in many. It will be found likewise of great use as a vehicle for colours; for, when dry, it is not easily affected by damp, or even by water.

With a solution of this kind, I have mixed various colours, such as, vermillion, fine lake, indigo, Prussian blue, sap green, and gamboge; and it is remarkable, that although the two last are of a gummy nature, and the others had been previously mixed with gum, (being cakes of the patent water-colours,) yet, when dried upon paper, they could not be removed with a moistened sponge, until the surface of the paper itself was rubbed off.

In many arts and manufactures, therefore, the solutions of lac may be found of much utility; for, like mu-

* Phil. Trans. 1781, p. 880.

cilage,

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silage, they may be diluted with water, and yet, when dry, are little if at all affected by it *.

We find, from the experiments on lac, that this substance is soluble in the alkalis, and in some of the acids. But this fact (considering that resin is the principal ingredient of lac) is in opposition to the generally-received opinion of chemists, namely, that acids and alkalis do not act upon resinous bodies. Some experiments, however, which I have made on various resins, gum-resins, and balsams, fully establish, that these substances are powerfully acted upon by the alkalis, and by some of the acids, so as to be completely dissolved, and rendered soluble in water.

It will be a very wide and curious field of inquiry, to discover what changes are thus produced in these bodies, especially by nitric acid. Each substance must form the subject of a separate investigation; and there cannot be a doubt but that much will be learned respecting their nature and properties, which hitherto have been so little examined by chemists.

The alkaline solutions of resin may be found useful in some of the arts; for many colours, especially those

* The alkaline-solutions of lac are evidently of a saponaceous nature, and, like other soaps, may be decomposed by acids. The entire substance of lac is not however completely dissolved, as appears from the turbidness of the liquors. Three of the four ingredients, namely, the resin, the gluten, and the colouring extract, appear to be in perfect solution; whilst the wax is only partially combined with the alkali, and forms that imperfectly soluble saponaceous compound which has been formerly mentioned, and which remains suspended, and disturbs the transparency of the solution.

From various circumstances, it does not seem improbable, that the long sought-for, but hitherto undiscovered vehicle employed by the celebrated painters of the Venetian School may have been some kind of resinous solution, prepared by means of borax, or by the alkalis.

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which are metallic, when dissolved in acids, may be precipitated, combined with resin, by adding the former to the alkaline solutions of the latter. I have made some experiments of this kind with success; and perhaps these processes might prove useful to dyers and manufacturers of colours. It is probable also, that medicine may derive advantages from some of this extensive series of alkaline and acid solutions of the resinous substances.

Observations on Basalt, and on the Transition from the vitreous to the stony Texture, which occurs in the gradual Refrigeration of melted Basalt; with some Geological Remarks. In a Letter from GREGORY WATT, *Esq. to the Right Honourable* CHARLES GREVILLE, *V. P. R. S.*

(Continued from Page 286.)

IF the preceding considerations be allowed to explain the formation of the first series of globules which consolidate into the jaspideous substance, they will also explain the formation of the larger and more distinctly radiated spheriods, which have been already stated to be very easily divisible into concentric fragments. They probably were also formed round a central point, by the accumulation of thin coats; and the tendency to radiation, which seems almost inseparable from this structure, was perhaps aided by the arrangement induced by the emission of heat from every part of the surface of the spheriods. This mode of formation has the advantage of explaining their impenetrability. Had they been generated by radii diverging from a centre, their compactness must have diminished as their diameter increased; but, in the structure which I have supposed, each coat is composed of particles solidly arranged

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ranged in immediate contact with each other, leaving no spaces for penetration. The same progress is rigidly observed in the extension of the compact nucleus, which always occupies the centre of the radiated spheriods, and finally extends to their peripheries. It observes the concentric divisions of the radiated part with the greatest precision; and the line of their separation is always perfectly defined. But the state of aggregation into which the substance has now entered, is so perfect as to overcome the operation of the causes which formerly induced the fibrous structure, and the mass remains compact. The only change that the substance afterwards undergoes, consists in the gradual accumulation of the crystalline molecules, and their arrangement, by their individual polarity, into regular solids. This depends on very different laws from those which consolidated the fluid glass, and aggregated its particles into a compact uniform stone *.

* The case is considerably different, where crystals possessing regular forms are generated in glass. The molecules of which they are formed, have doubtless been only suspended in the vitreous medium; and their union is determined by crystalline polarity, which appears to me perfectly distinct from the simple aggregation which changes a fluid into a solid, whether it be homogeneous or compound, which affects the internal arrangement of those bodies, but which never can separate their components into distinct masses, or form them into regular solids. Every molecule, at the moment of its formation, must necessarily be endowed with all the properties it afterwards possesses. The suspension of such molecules in a fluid medium, though it may conceal, cannot alter those properties; and the union of such molecules, to form a regular solid, in no respect alters their individual or aggregate qualities. Whether heat be evolved at the moment of this union, is a question not easily solved; as the crystallizations with which we are familiar are from chemical solutions, in which some of the molecules are generated by the separation of a combined substance, at the moment when others are united by crystalline polarity.

The

The appearances that I have endeavoured to describe, seem deserving of consideration in several points of view. Few things can be more at variance with commonly-received opinion, than the diversified succession of changes of structure which this glass exhibits in its passage to a crystallized state. The generation of the globules which unite to form the jaspideous substance, is what we might be prepared to expect, by observing the cooling of a common iron furnace flag. But it appears not very obvious to common apprehension, that the species of arrangement requisite to form this intermediary substance, could be incompatible with any fluidity permitting farther motion of the molecules of the mass; yet, immediately after the completion of this arrangement, they receive a new disposition, and the radiated fibrous structure commences. Sometimes this pervades even the unaltered glass; but I presume this only to happen where the minute globules first formed were scattered so far asunder, that their centres became fibrous, before their peripheries came into contact. This view of the subject is justified by the analogous operation of the formation of crystals, similar to those described, in the heart of the radiated spheroids, while their exteriors still retained the fibrous texture.

If it be considered as extraordinary, that a change should be effected, converting an apparently solid and homogeneous mass into an accumulation of radiated spheroids, and that these radii should lose their fibrous structure, and assume the texture, aspect, and tenacity, of a compact, hard, and homogeneous stone, it is certainly much more extraordinary, that this stone should permit farther arrangement to proceed, and should enable the crystalline molecules which it contains in a state of confused aggregation, to arrange themselves, and to form crystals,

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crystals, which, although minute, are equal in the perfection of their forms, and in the brilliancy of their natural polish, to the most precious products of crystallization. It is also well deserving of observation, by how regular a march the magnetic influence of the substance keeps pace with the perfection of its arrangement, till it becomes so powerful, that fragments of the regenerated stone are suspended by the attraction of a magnet.

It has been most justly remarked by Mr. Smithson, that solution, far from being necessary to crystallization, effectually prevents its commencement; for, while solution subsists, crystallization cannot take place. It may remain a question, whether previous solution be essential, as a preparatory means of obtaining, by subsequent evaporation, or cooling, the small parts of bodies disengaged, so that they may unite to form regular crystals. If by solution be only meant, that simple action of heat, or water, which merely counteracts the force of aggregation, and relieves the molecules from their bond of union with each other, it certainly is requisite; but if by solution be meant, that action of affinities by which not only the force of aggregation is overcome, but the combinations which constitute the molecules are destroyed, it obviously is not only unnecessary, but prejudicial to crystallization; as a new set of molecules must be formed, by a new combination of the elementary particles, before the formation of regular bodies can commence. The suspension of the molecules ready to crystallize, may be correctly said to be merely mechanical. Though the mechanical action of trituration can never be expected to resolve even the most easily divisible body into its molecules, because the fracture will be at least as frequently across the natural joints as in their direction, yet, even by this rude method, some perfect molecules may be dis-

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disengaged; for we find, that water passing over large surfaces of siliceous sand, finds some molecules of silex in the state proper for aggregation, and even for crystallization. Mechanical suspension in a fluid medium, of such density that the crystalline polarity may be enabled to counteract the power of gravity, is with justice considered by Mr. Smithson the only requisite for the formation of crystals *. The circumstances I have detailed, appear to me an additional confirmation of this remark, and perhaps go still farther, by showing that even the fluidity (in the common sense of the word) of the suspending medium is not an indispensible condition. For it appears impossible to annex the idea of fluidity to the union of the minute globules which form the jaspideous substance, still less to that substance when formed, and still less to those spheroids whose obstinate impenetrability is so strongly defined. And if, by any power of imagination, these can be supposed to be fluid at the time they retain this confirmation, how can it be supposed that the compact hard tenacious stone into which they are changed could retain these characters in a fluid state? Yet the subsequent formation of crystals proves, that either all these contradictions must be, or that the particles of bodies apparently solid must be capable of some internal motion, enabling them to arrange themselves according to polarity, while they are solid and fixed, as far as they have reference to the ordinary characters of fluidity.

Instances even more remarkable have very lately been known and authenticated, though perhaps they have not been generally regarded with the attention they deserve. Glass vessels are well known to be convertible into Reaumur's

* See a chemical Analysis of some Calamines, by James Smithson, Esq. Philosophical Transactions for 1803, page 27. See also Dolomieu, *Journal des Mines*. No. 22, page 53.

mur's porcelain, by the internal arrangement of their particles, without losing their external form, and consequently at a temperature very much below that requisite for their fusion. The change of glass into Reaumur's porcelain, does not arise from an evoration of the alkali, as has been alleged, but from a regular arrangement of the molecules of the glass. It commences by the formation of fibres perpendicular to the surface of the glass, and penetrating into it. At nearly the same time, small radiated globules are formed in the interior of the glass, and the union of these with the fibres, by their mutual increase, forms the whole into a new substance; and, if the requisite temperature be longer maintained, the fibres disappear, and the whole becomes fine-grained, and almost compact. This substance, from the improved state of its aggregation, is much stronger and more tenacious than before, and is not fusible at a heat sufficient to fuse the glass it was formed from; but, if that aggregation be once destroyed, the glass resulting from its fusion is equally fusible with the original glass; and a repetition of the process will again form Reaumur's porcelain, which may be again fused, and so on repeatedly, for the the quantity of alkali evaporated during the operation is extremely small. The hardness and brittleness of metals rapidly cooled, contrasted with the softness and tenacity resulting from their gradual refrigeration, are all analogous instances; and all the processes in which annealing is employed, and more remarkably the tempering of steel, are proofs of the internal motions and arrangements of the particles of matter, at temperatures very much below the heat requisite for their fluidity.

Whatever doubts may arise respecting the formation of the crystals, there seems no reason to suppose that their

gradual increase would cease, till all the molecules belonging to that species were exhausted, if the temperature favourable to their generation was continued. If the mass was entirely composed of one species of molecules, it would be resolved into an aggregation of crystals of the same substance; and probably, by a still farther continuation of the process of arrangement, into one crystal, which, though it might not possess a regular external form, would be perfect in its internal structure.

But, if the mass contains two distinct species of molecules, different results must take place, which will be modified by the proportional quantities of the components. As it has been demonstrated by Berthollet, that the attraction of masses of matter are relatively as their quantities, it follows, that unless a very potent counteracting cause be exerted, the most abundant ingredient in the mixture will be the first to crystallize. But this crystallization will not comprehend the whole of its molecules; for, after a certain quantity of them are arranged, the proportions of the remaining fluid are altered; that ingredient which was before the least, may now be equal, or even greatest, and it will exercise its attraction. As the first crystallization, by subtracting a large portion of the fluid particles, must have obliged the molecules of the less abundant substance to approach each other very closely, they may be able to collect themselves entirely in their first attempt to crystallize, or they may form alternate crystallizations with the remaining unarranged molecules of the more abundant substance. However various the species of molecules may be, they will be regulated by analogous laws, and only serve to diversify the generated substances.

It

It by no means follows, that the crystals afterwards found to be most infusible would be first generated. Their formation does not altogether depend on their greater or less fusibility, but on the relative strength of the attraction which unites them to the matter they are immersed in, and of the polarity which invites them to crystallize. In all crystallization from compound fluids, the order in which the several bodies crystallize must be determined by their relative quantities and attractions. It is perfectly obvious, that no molecules can form a crystal in a heat sufficient for its fusion; but it by no means ensues, that it will be formed as soon as the molecules are cooled to the point where the crystalline polarity overcomes the disintegrating power of heat; for they may remain suspended in a fluid formed by more fusible bodies, provided this fluid be sufficiently abundant to keep them from contact with each other, for the crystalline polarity appears to exert itself only at extremely small distances. In a mass composed of substances in a state of fluidity, with refractory molecules suspended among them, it is pretty clear, from the preceding paragraph, that the most abundant ingredient will be the first to crystallize. But the removal of a portion of the suspending fluid must bring the refractory molecules nearer together, and perhaps so near that the crystalline polarity may overcome the attraction of the fluid for them; they will therefore crystallize next, and will be followed by the remaining ingredients, in the order their attractions dictate.

As the crystals last formed must necessarily be impressed, at the parts in contact, by the peculiar forms of those which have been first generated, it also follows, if the preceding reasoning be just, that the infusible crys-

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tals may be found impressed by the more fusible substance, which crystallized first; and the remaining ingredients of the mixture, which were subsequently arranged, may be moulded on the refractory crystals; and thus, in the same specimen may exist, a refractory substance generated by fire, impressed by more fusible bodies, and impressing them in its turn. From the same consideration it is obvious, that no crystal can be formed at a temperature above the degree of its fusibility; and that, as a necessary consequence, no crystal which is more fusible than the basis in which it is imbedded, can be formed by igneous operation.

The same laws must regulate the arrangement of aqueous solutions, and of molecules suspended in aqueous solutions. All these are dependant on heat; for we are unacquainted with any fluidity, and consequently with any solution, which heat does not produce. Ice and soda have no more action on each other than soda and quartz; raise the temperature of the ice, and it unites with the soda; raise the temperature of the soda, and it unites with the quartz. Both solutions are effected by heat, of the degrees of which we know neither the beginning nor the end, and are therefore utterly unable to estimate what aliquot part of its scale is adequate to the production of these effects. Probably a very minute one.

A curious diversity may prevail in the products of a compound body subjected to fusion, when absolute solution is produced. When merely simple fusion takes place, the aggregation of the parts only is destroyed; the fluidity arises from the facility with which they move on each other; and a regulated diminution of temperature, by facilitating their reunion, can hardly fail to recompose the same species that formerly appeared to exist

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in the compound. But, if the molecules have been dissolved and decomposed, and their component particles diffused through the fluid, there seems to be very little probability that any reunion should compose the same molecules. It is more likely that new compounds will be formed, from which new molecules, and of course new crystals, will be generated; and that, consequently, the same rock may become the parent of very diversified offspring. These will however retain some traces of their origin; for, as there can be no fusion of a compound body imagined, in which the mutual action of the components will not decompose some portion, there can be no solution supposed so perfect that every molecule shall be destroyed. In the first case, there will exist the germs of a new composition; and, in the second, there will remain the relics of the old.

If these observations are correct, considerable utility seems derivable from them, in the explanation of some geological problems. It will appear, that they strikingly illustrate the analogy which exists between the aqueous and igneous formations, and show that precisely the same order and kind of arrangement is followed, in the generation of stony masses from water as from fire; for, the change of structure, which I have observed to be the most inexplicable part of the process by which glass passes into stone, is almost exactly imitated in the formation of calcareous stalactites. Successive depositions of calcareous carbonate, form a stalactite which at first is fibrous. A continuance of the process causes the fibrous structure to disappear, and the stalactite becomes irregularly spathose. The irregularities then vanish, and it becomes perfect calcareous spar, divisible into large rhomboids, with the form peculiar to that mineral; and all the gradations

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gradations may be found in the same specimen. Nor is this change confined to a few solitary specimens; for, a considerable extent of coast near Sunderland, is formed of a limestone composed of radiated spheroids, from half an inch to three inches diameter, imperfectly united. When one of these spheroids attains something more than the usual magnitude, it becomes compact in the heart; and it is not unusual to discover portions of the rock, in which the radii have entirely disappeared, and the whole mass has become compact. It is probable that the entire formation of oolithi and pisolithi is owing to the same cause; and that they are prevented from ever arriving at great size, by the union of their surfaces, and their subsequent consolidation into compact limestone, into which they are continually found to graduate.

TO BE CONCLUDED IN OUR NEXT.

Description of an improved Safety-Valve for Steam-Engines, containing a Vacuum-Valve in the same Hole of the Boiler.

Invented by the Chevalier A. N. EDELCRANTZ, *of Sweden.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal was voted to the Inventor.

IN large boilers or coppers, where boiling fluids are enclosed, a safety-valve is generally used to prevent their bursting, from an unexpected excessive force of the elastic

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elastic steam, and, besides a vacuum-valve, to prevent their being compressed or crushed by the weight of external air, in the case of a sudden condensation of the vapours. These two valves are commonly fitted into two different holes in the boiler; but as a more simple, and consequently more eligible, method seems to be that of joining them together, I submit the following contrivance for that purpose.

a b, (Plate XVI.) Fig. 9, is a common conical safety-valve, fixed in the boiler *c d*, having four openings, *i i*, which are represented in a plan-view in Fig. 10. *e f* is the metallic rod, bearing the weight K K, with which the safety-valve is loaded, and extending itself under that valve to *f*: *g h* is the vacuum-valve, consisting in a plane circular plate, with a brass tube sliding along the rod, and pressed by a spiral spring to the safety-valve *a b*, (against which it has been well ground in making it,) closing in that situation the openings *i i*.

Such being the construction of the whole, it is evident, that when the elasticity of the steam increases, the two valves, joined together, with the holes *i i* shut, make but one, opposing to the elasticity of the steam an united resistance, which is regulated by the weight K K, in the common way; but, on the contrary, when by condensation of the vapours a vacuum is produced, the external air in pressing through *i i*, upon the vacuum valve *g h*, forces it down, and opens to itself a passage into the boiler.

The valve *g h* may easily be made conical, like the other, if that form should be preferred; but in different trials I have found planes, if well turned and ground together, join as perfectly as can be desired, being pressed by the united elasticity of the spring and the steam.

Fig.

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Fig. 11 is the same contrivance, adapted to a new kind of safety valve or piston, which, though I originally intended it for the use of Papin's digesters of a new construction *, has been, in a larger size, applied by me even to steam-engines, and is described in the Philosophical Magazine of December, 1803 †.

I have lately begun, and shall pursue, a set of experiments, with the intention of regulating, by this safety-piston, the quantity of admitted air to fire-grates, and to effect, by that means, a new mode of regulating the fire, and the elasticity of steam in boilers, with less expenditure of fuel and of force than usual: of which idea a hint is given in the work and place above mentioned. The result of these researches I shall at some future period do myself the honour of communicating to the Society.

* Nicholson's Journal, March, 1804.

† The description of this contrivance being already published, it would be superfluous to repeat it. I only beg leave to add the following practical remark. A metallic piston, if well turned and fitted into a cylinder of exactly the same kind of metal, will probably have the same degree of expansion, especially if hollow, and consequently will not increase its friction in any increased degree of temperature. But as in practice the cylinder is commonly exposed to a lower temperature than the piston, heated by the steam, a little increase of friction will take place by an increase of heat. To prevent the effect of this, I have found it useful to employ for the piston a metal of somewhat less expansive powers than the cylinder; and the expansion of red copper being to that of brass nearly as 10 to 11, I prefer making the piston of the former metal, when the cylinder is made of brass.

Description

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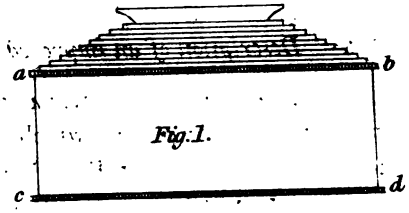


Fig. 1.

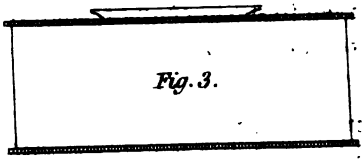


Fig. 3.

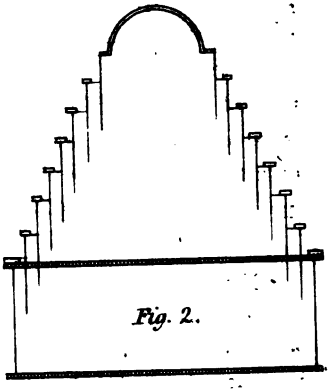
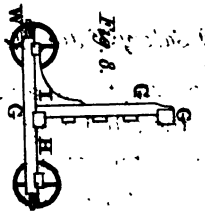


Fig. 2.



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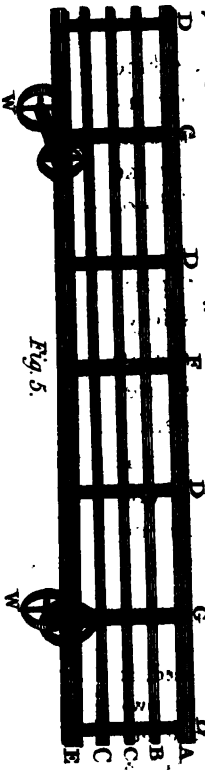


Fig. 5.

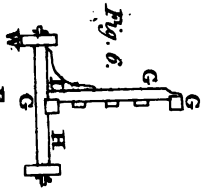
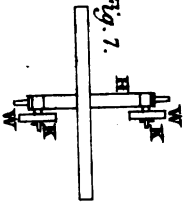


Fig. 6.



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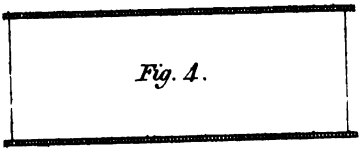
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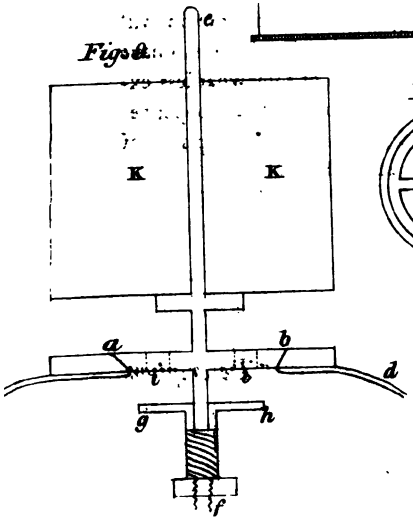

Figs 9.

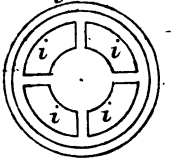

Fig. 10.

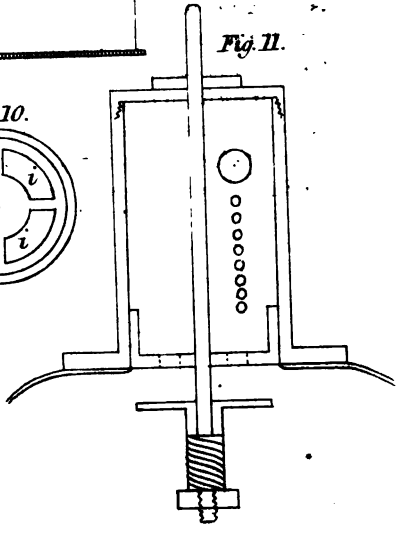
Fig. 11.

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Description of a Machine to ascertain the Number of Lifts made from a Mine, in any given Time.

Invented by Mr. JOHN ANTIS, *of Fulneck, near Leeds.*

With a Plate.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

Ten Guineas were voted to Mr. ANTIS *for this Invention.*

I HAVE lately been encouraged by some gentlemen engaged in some coal mines in this neighbourhood, to invent a machine, which would infallibly tell the number of boxes of coals drawn out of a pit in the course of a week, or any given time. I have just now completed a model, which I think would answer the purpose extremely well.

The machine is very simple, and need not be expensive; its properties are as follow:

1. It is of no consequence if the pit be ten, twenty, forty, or more yards deep. It will, notwithstanding this difference, only point out one box at once; and, supposing the pit to be several hundred yards deep, the principle will remain the same, and the machine could be easily adapted for it.

2. It is likewise of no consequence if the coals be drawn up by a hand windlass, or any other machine turned by horses or other powers.

3. No account is necessary to be kept for a whole week, or any given time, as the machine can be calculated for any quantity of coals whatever, that can be drawn up in a given time. Only allowance must be made for the number of persons that go down and up in the same way.

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I have not yet heard of any contrivance of this kind; and therefore, if there be any such, it is unknown to me. Whoever knows the fraud, which is but too often committed by banksmen, in accounting for the quantity of coals procured from a pit, will readily admit the utility of such a contrivance. And it may most likely also be useful in tin, lead, and other mines.

I am so little acquainted with coal-pits, or any other mines, that I do not know the technical terms by which the different parts are called, nor all the methods now used to draw up those materials; I must therefore beg indulgence, if I do not always express myself with accuracy.

By inventing this machine, I aimed at ascertaining the number of boxes, my ideas respecting which I will endeavour to describe, to the best of my abilities.

First, the rope must be so long, that it can be fastened at its middle to the windlass, and that each end thereof may reach to the bottom of the pit. This precaution will not be necessary, if it can be prevented by any other means from shifting or sliding, which I leave to others, more acquainted than I am with the present practice, to effect.

The roller A, (Plate XVII.) Fig. 1, in the model, with the endless screw, represents the gudgeon in full size of a hand windlass, such as are used in this neighbourhood, particularly where the pits are of considerable depth. As no great stress is laid upon this screw, it may be made, in order to save labour, of brass, and driven, or otherwise fastened, upon any gudgeon. I suppose the windlass to be one yard in circumference; and consequently forty revolutions of the windlass are required before the first wheel B, upon which the brass catch C is fixed, turns once round. The pit, therefore, may be only

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only ten yards, or from seventy to seventy-five yards deep, yet it will make no difference. All that is required to regulate the machine to the depth of the pit is as follows:—If the pit be little more or less than ten yards, the first wheel must be so placed in the endless screw, that the brass catch C may be at the beginning, but just escaped from the cogs of the second wheel D. It will then only want five or six revolutions of the windlass backwards, before the said catch is ready to operate again. But supposing the pit to be seventy yards deep, in this case, the catch C must be placed so as nearly to be ready to act. By turning backwards, the wheel may very nearly make two revolutions; and as it can be still turned as far the other way, the catch will only act once, provided the said wheel does not quite make two revolutions.

The model is about the size required for a common hand windlass. The index will at once show how many times fifty boxes, and how many above and below that number, have been drawn up: not one of them can escape. Allowance, however, must be made for the number of persons who go up and down in the same way. Besides this, since one box is always coming up, whilst the other is going down, the numbers pointed at must be doubled, except a person was desirous to have a machine acting both ways, which would hardly be worth while. As the machine is at present, though it points out a thousand boxes only, yet it will serve for two thousand.

The same mechanism, with very little variation, may be fixed to a horse machine, called a gin, in this neighbourhood; viz. as a gin may be ten yards or more in circumference, the action would be too slow, if moved by an endless screw; a pinion, with four leaves, will be

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found much more convenient. This pinion is fixed to the end of the upper gudgeon, which enters the box containing the machinery. As some accuracy is required to make such a pinion work well, and these machines are often coarsely constructed, it will be necessary only to make about one inch and a half of the end of the said gudgeon exactly round, namely, that part of it which goes through the bottom of the box, and then fasten the latter so, that it can give way to any remaining inaccuracy of the other parts of the gudgeon.

I have sent a drawing * of such a machine, which will be easily understood, since the principle is the same as in the model. But as gins are commonly made use of in deep mines, I have made it upon a larger scale; viz. the first wheel has sixty-four cogs; and this, with a pinion of four leaves, will require sixteen revolutions of the gin, for one of the wheel. Allowing ten yards for the circumference of the gin, it will make one hundred and sixty yards of rope; and considering that the said wheel can nearly make two revolutions, and that the catch will still act only once, it will consequently serve for a pit of three hundred yards deep, as well as for one of ten or twenty.

In this machine, the three wheels are placed one on another, and the index is divided; viz. the fifty on the second, and the 1000 on the third wheel. As the wheels move, the two hands are standing, which will point out the numbers as exactly as those in the model. Indeed, machines for hand windlasses may be made in the very same way, and thereby be more simple, though the difference is but small; viz. the box would require but one lid and lock, and the two smaller wheels become unnecessary.

* This drawing is in the Society's possession.

Though

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Though in setting the machine so as to begin counting with one, it may easily be effected by lifting out the spring, and then turning the wheel with the other hand, till both hands stand upon one, yet, in the double index, the upper hand must only be set thus with the wheel, and the lower may be moved round on its socket.

In my humble opinion, my machines may be useful in two ways; first, to the honest banksman, as they will save him the trouble of noting down each box which is drawn up, and prevent mistakes; secondly, in the prevention of fraud, which will be their greatest and most important use. To obtain this end, it is necessary that the machine be so contrived, that nothing essentially wanted can be disengaged. I have therefore made the model so as to frustrate any such design. All is within the box; and neither the endless screw can be disengaged from the wheel, nor the spring: nor can the number on the index be altered without first opening the box. This latter can be made of iron, if found necessary, with a good lock to it; otherwise, the stress is so very little, that even one of wood, made in all respects like the model, would answer, if it could be secured from the effects of the weather. In the machine likewise, represented by the drawing, nothing can be altered, except the box be first opened. This machine is fastened to the beam in which the upper gudgeon turns. To effect this, the bottom of the box must have two projecting ends with holes in them, larger than necessary to receive a strong pin or rivet; which pins must have large heads, so that, when properly driven or riveted in, the box may be able to give way to any remaining inaccuracy in the lower parts of the gudgeon, as I before observed. Those machines for hand windlasses, like the model, are fixed to the side of the post into which one of the gudgeons turns;

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turns; but perhaps these might likewise be contrived so, that the gudgeon with the endless screw may be a piece by itself, attached only to the windlass by a square, or otherwise, as is often practised in other machineries, such as cotton-mills, &c.

Reference to Plate XVII.

Fig. 1. A, the roller, with an endless screw, to be the size of the gudgeon of a hand windlass.

B, the first wheel, of forty teeth, with a brass catch C. It may be moved backwards or forwards by the endless screw.

D, a rachet wheel with fifty teeth, which, when the wheel B is put in motion one way, the catch will slide over the teeth of it; but, on turning it the other way, the catch will drop into and forward this wheel one tooth, in which situation it is prevented from returning by the spring E, placed on the side of the box which holds a tooth on the side of the wheel.

F, a small pinion of four teeth, on the back part of the axle of the wheel D. This pinion moves a large wheel on the other side of the box.

Fig. 2. G, the large wheel last mentioned: it has eighty teeth.

H, a smaller wheel of fifty teeth, fixed fast on the face of the wheel G; which wheel H works a wheel I, of the same number of teeth, shown by dotted lines behind the figured dial-plate.

The short hand, or finger of the dial, is placed upon an arbor or collar of this wheel I, and moves with it.

The long finger, or hand of the dial plate, goes upon a square on the end of the spindle on which the above arbor moves; which spindle moves forward this long finger one division in fifty of the outer circle marked on the

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Fig. 2.

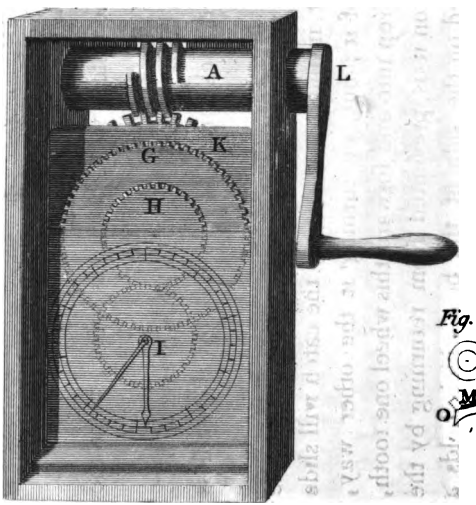

Fig. 1.

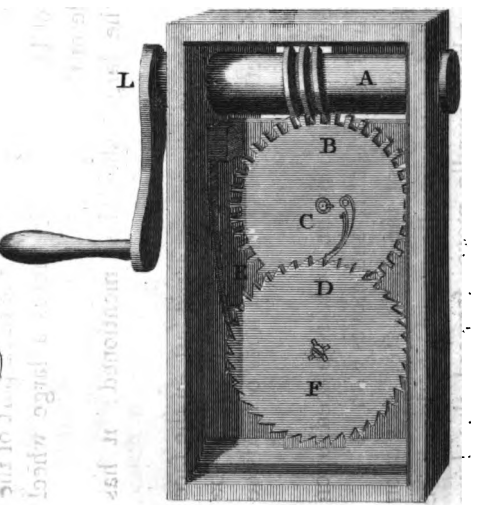

Fig. 3.

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the dial-plate, every time the rope, or any thing attached to it, has been down to the bottom of the mine, and returned to the top.

The inner circle of the face of the dial is marked in divisions of fifty each. When therefore fifty draughts up and down have been made from the mine, the shorter hand will be found, if both hands were originally set correctly at the top, to have moved to the first interior division marked 50; and so on, in proportion, will advance as more draughts are made.

K, is a board placed under the wheels B D, in Fig. 1, and which separates them from the other wheel-work in Fig. 2, where only a few teeth of the wheel B appear behind it.

L L, show the temporary handles in both figures; and the position of those letters denote that the gudgeon of the windlass, when the machine is in actual use, should be there joined to, or make a part of the roller A.

Fig. 3, shows, on an enlarged scale, the form of the catch C. The steel spring M pressing against the pin N, returns the catch to the tooth of the wheel D, when it has been forced back; and a pin fixed underneath the catch moves in a groove O, made in the wheel B, to prevent the catch being pressed too far back, or thrown out improperly by the spring.

A door is fixed on each side the box, and should be locked, to prevent the hands being altered unknowingly.

The drawing of a machine for similar purposes, intended to be used with a gin or horse wheel, alluded to in Mr. Antis's letter, is in the Society's possession, if a reference thereto be thought necessary.

Comparative

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Comparative Analysis of several Varieties of Steatites or Talcs. By M. VAUQUELIN.

From the JOURNAL DE PHYSIQUE.

HITHERTO it had been imagined that the smoothness and unctuosity of the stones called steatites proceeded from the presence of magnesia, because this earth had been found in all those which had been analysed, and consequently all the stones which present these characters had been united in the same species. But the analysis of the lard-stone, which is in some measure to be regarded as the type of the species, and in which M. Klaproth found no magnesia, has deranged the notions of mineralogists on this subject, and gave them reason to wish that the analysis of some of these substances might be undertaken anew.

It was with the intention to remove this uncertainty that M. Haüy sent me these varieties of talc, in order that I might subject them to comparative analyses.

The first of these substances is termed, in the Treatise on Mineralogy by this author, *laminary talc*; it is of a greenish-white colour when viewed in the mass, very soft to the touch, and divides into extremely thin flexible laminæ of a silvery-white hue. The second is designated in the same treatise by the name of *glaphic talc*, because it is employed in sculpture; it is what is generally named *lard-stone*, or the *Bildstein* of the Germans. It is compact, its fracture is dull, rough, and at the same time scaly; it is very unctuous to the touch, and its colour varies between the grey, the yellowish, and the greenish.

M. Haüy has sent me two specimens of this last species; the one of a yellowish-white colour, obtained from a broken Chinese idol; the other of a light rose colour, but in other respects perfectly similar to the first specimen.

Analysis

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Analysis of the flexible laminary Talc.

1. I calcined with a strong heat a hundred parts of this stone: it acquired, by this operation, a yellow colour, with a slight rose tinge; it lost its flexibility, and six parts of its weight. These laminæ were thus become very brittle, so that I could easily reduce them to powder.

2. I heated these hundred parts, thus calcined, with double the quantity of caustic potash; the mixture was not fused, but the intumescence which it underwent shewed that a combination had taken place between these substances.

3. The matter, diluted with water, was then dissolved by muriatic acid, and evaporated to dryness with the aid of a moderate heat; the liquor formed a jelly towards the end of the operation.

4. The residue, lixiviated with distilled water, left a white powder, which, calcined to redness, weighed 62 parts. This was pure silex.

5. Ammoniac, mixed with the liquor separated from the silex, formed in it a yellow precipitate, of little bulk, from which a part and a half of alumine was separated by means of caustic potash: the rest was oxyde of iron, which weighed $3\frac{1}{2}$ parts.

6. After having precipitated the iron and the alumine by ammoniac, I put into the liquor a solution of carbonate of soda, and boiled it. As soon as the liquor began to be heated, it became turbid, and deposited a large quantity of white powder, which, when washed and calcined, weighed 27 parts. This substance was magnesia, for it formed, with the sulphuric acid, a salt which had all the properties of the ordinary sulphate of magnesia.

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The flexible laminary talc is therefore composed of

Silex	62.
Magnesia	27.
Oxyd of iron	3.5
Alumine	1.5
Water	6.
	100.0

With respect to the small quantities of iron and of alumine, I think these substances may be considered as extraneous to the formation of this stone: thus very pure laminary talc would be composed only of silex and magnesia.

Analysis of the compact rose-coloured Talc.

In the analysis of this variety of talc, I employed the same processes as in that of the preceding, and shall therefore not enter into any minute detail of them.

The results of this analysis gave, for the compact rose-coloured talc,

Silex	64.
Magnesia	22.
Alumine	3.
Iron mixed with manganese	5.
Water	6.
	100.

Analysis of the compact yellowish-coloured Talc (Lard-Stone.)

1. A hundred parts of this stone, strongly calcined, lost five parts.

2. Heated afterwards, with twice its weight of potash, in a silver crucible, it underwent no fusion, but the matter had considerably increased in volume, and was become very homogeneous.

3. The

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3. The matter was diluted with water, and dissolved in muriatic acid; the solution, subjected to evaporation, formed a jelly towards the end of the operation.

4. The matter, after being dried, was washed with distilled water; there remained a white powder, which, when calcined, weighed 56 parts.

5. After having separated the silex by lixiviation, a small quantity of muriatic acid was mixed with the liquor, and ammoniac was then poured into it, which formed an abundant white and flakey precipitate.

6. The liquor was filtrated; the precipitate was washed and dried; its weight was 30 parts, and it was alumine. This alumine dissolved entirely in sulphuric acid, and its solution, saturated with the requisite quantity of potash, afforded very pure alum; but the mother-water, evaporated anew, yielded 5½ parts of sulphate of lime crystallized in needles. Thus ammoniac precipitated, with the aid of the alumine, the lime from its solution in the muriatic acid.

7. The liquor from which the alumine had been separated gave no precipitate with the carbonate of soda, not even with the aid of long ebullition. Thus the lardstone does not contain any magnesia, like the two preceding varieties of talc.

But when we recapitulate the products of this analysis, we find only 93 parts, namely,

Silex	56.
Alumine	29.
Lime	2.
Iron	1.
Water	6.
	93. *

* There appears to be an error in these figures, for the parts when cast up amount to 94.

This considerable loss, which is not common in analyses of this kind, when carefully conducted, led me to suspect that the compact talc (lard-stone) contained some other principle which the processes employed could not enable me to discover. I therefore heated a hundred parts of it, reduced to a fine powder, with concentrated sulphuric acid.

After having boiled for two hours, I dried the mixture; I lixiviated the residuum with distilled water, and evaporated the lixivium. At the end of some days, I obtained 36 parts of alum in cubic crystals. By a second evaporation the mother-water yielded me still fifteen parts of the same salt, mixed with some needles of sulphate of lime.

As the stone appeared to me to be but imperfectly decomposed, I pulverised it anew, and treated it as at the first time. By uniting the acid which I had employed in this operation with the mother-water of the first, I obtained still 15 parts of alum, which makes in all 60* parts. Thus, as I employed in this operation very pure sulphuric acid, and did not add potash to the solution, it is evident that the stone contains a certain quantity of this alkali, and that this substance is the cause of the loss which I had in the first analysis.

However, the 60 parts of alum do not represent the 7 of loss sustained, but the stone being very siliceous, it is probable that the whole of the potash had not been extracted by the sulphuric acid, although I boiled it two different times upon the stone.

* This, according to the preceding statement, should be 66.

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The lard-stone is therefore composed of

Silex	56.
Alumine	29.
Lime	2.
Iron	1.
Water	5.
Potash	7
	100.

M. Klaproth, in his analysis of the lard-stone, found no potash in it, but the quantity of water which he reckons at 10 to 100 in this stone, and the loss of two and a half which he found, exactly correspond with the deficit which I experienced. It was probably more by conjecture than by direct experiment, that M. Klaproth estimated the quantity of the water; for to whatever heat I have exposed this stone, it has never lost more than five in the hundred.

It results from these analyses, that of the three varieties of talc of which I have been treating, only two ought to remain in the species of talc; namely, the laminary and the compact rose-coloured; the third, the lard-stone, ought to be ranked in the genus of *alkaliniferous* stones.

What is remarkable is, that they are the two varieties that have the greatest resemblance with each other, and that have always been united, which now are separated by analysis; and this proves that minerals ought never to be classed according to their external appearances, since the most striking analogies are here the most fallacious.

In fact, the lard-stone and the compact rose-coloured talc have the same smoothness, the same fineness in their molecules, the same fracture, and nearly the same specific

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specific weight; and certainly, if there had been reason to suppose that one of these three substances ought to be separated from the species of talc, we should have inclined rather to fix upon that which is disposed in laminæ than upon either of the others.

Note. I have analysed, on this occasion, the species of talc known by the name of Briançon chalk, in which I have found the same principles, and nearly all the same relations, as in the laminary talc and the compact rose-coloured talc.

These proportions are,

Silex	61.25
Magnesia	26.25
Water	6.
Alumine	1.
Oxyd of iron	1.
Lime	0.75
Loss	3.75

Second Extract of M. Payssé's *Memoir on the Preparation of some Oxyds of Mercury in the large way.*

By M. PARMENTIER.

From the ANNALES DE CHIMIE.

NOTHING more remains to be done, in order to put our readers in possession of the substance of M. Payssé's interesting memoir on the oxyds of mercury, than to give a sketch of the other experiments which he has made relative to the red oxyd of mercury by the nitric acid (red precipitate): they form the supplement to his process inserted in our preceding numbers *. This process, if followed,

* See pp. 152 and 261 of the present volume.

lowed, will remove all the uncertainties of the manufacturing chemists, who have hitherto not been able to prepare this substance as is done in Holland. Every thing is easy in the theory; but in the arts, facts speak much better than the most brilliant reasonings; and it cannot be doubted, that if the French government would establish several manufactories, in which all the products were prepared in the large way, more experienced chemists would be formed than in all our schools; for here true instruction would be obtained; all the reasonings would be deduced from the phenomena observed in great operations; the pupils would become familiarly acquainted with the arts of manipulation; they would derive from these practical seminaries just notions respecting the modes of proceeding, and we should no longer see a number of men, otherwise very well informed, risquing their fortunes, and those of others, in forming establishments which they cannot make to prosper for want of knowledge in the art of operating on a large scale. France, in this respect, is behind Holland, notwithstanding the very great number of able chemists she possesses. Such are the judicious reflections of M. Payssé; but let us proceed to consider the last results of his labours.

In order to assure himself that the crystalline state of the red oxyd of mercury by the nitric acid is not owing to a semi-vitrification, as M. Van Mons has supposed, he made a solution of mercury in nitric acid mixed with some hundredth parts of muriatic acid; after having evaporated this solution to dryness, he treated this matter with the same care and caution as the first; and the operation being finished, the mercurial oxyd presented a red aspect, fine enough in some parts, dull in some others, but without any appearance either of brilliancy or crystallisation.

tallisation. This matter was pulverized and introduced anew into another glass vessel, at the bottom of which he used the precaution to introduce a small quantity of nitric acid, in order that it might slightly impregnate the mercurial powder; and he proceeded as before, exposing the vessel to a gentle and graduated fire. Notwithstanding all the precautions which he observed, during the operation, the oxyd which was its result passed into the red state, without presenting the slightest vestige of crystallisation or of brilliancy. This experiment, thrice repeated, always proved equally unsuccessful. It is however evident, that if the red oxyd of mercury owes its brilliancy only to the semi-vitrified state into which it passes when it is heated, there is no reason why it should not be constantly in the same state whenever it is prepared, since, according to the Brussels chemist, nothing more is required than to apply to it a brisk temperature between two crucibles luted together.

In preparing the red oxyd of mercury, M. Pavs made some observations which gave him reason to suspect that the brilliant state of this substance depended more upon the precise degree of oxygenation of the mercury than upon any other cause; that the presence of the muriatic acid in the nitric was an obstacle to the formation of this brilliant state, by the new compounds to which it gives rise during the operation. What he had only suspected is now rendered certain, as the following experiments will serve to evince.

He took a hundred parts of brilliant red oxyd of mercury, prepared by the nitric acid mixed with the muriatic; the oxyd being introduced into a matrass with a long neck, provided with a curved tube of glass, communicating with the pneumato-chemical apparatus, was gradually heated till the bottom of the vessel became red

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hot; he let all the atmospheric air contained in the apparatus escape, in order to obtain exempt from mixture the oxygene gas which the oxyd furnished; after having heated the matrass for a sufficient length of time, and awaited the complete reduction of the mercurial oxyd, he let the whole cool, and unluted the apparatus; he decanted the mercury, and collected all that which had attached itself to the neck of the matrass; its whole weight was 0,81. The receiver which had served to collect the oxygene gas was obscured, and indicated that a small quantity of mercury, raised in the gaseous state, had condensed itself upon its inner surface: in order to force the oxygene gas to abandon all the metallic parts which it might contain, he surrounded the recipient with pounded glass; when the recipient had cooled for the space of an hour, he transfused the gas into another vessel, and carefully collected all the mercurial oxyd which lined the inside of the vessel; a slight friction, with the finger against the glass, was sufficient to effect its reduction, and to collect it in brilliant globules; its weight was 0,02, which, with the 0,81 found in the matrass, gave 0.83. The neck of the latter vessel presented small white crystals, which he carefully collected; their weight amounted to about 0.01; their taste, as well as all their chemical properties, convinced him that they were superoxygenated muriate of mercury. A reddish powder, inclining to the brown, also lined a part of the cavity of the matrass; this required to be broken, in order to be collected; on examining it with attention, he found in it the characters and the properties of that new combination, which has already been spoken of in the beginning of this memoir, and which he has termed muriate of mercury, with excess of oxyd; its weight was 0.03. From these results it is evident that the quantity of oxygene

was 0.13. The same experiments were repeated several times successively upon similar oxyd of mercury, and the results were constantly the same as the preceding.

A hundred parts of red oxyd of mercury, very brilliant and well crystallised, prepared by nitric acid exempt from muriatic, were treated in the same manner as in the preceding experiments, of which an account has been given above; the reduction of the mercurial oxyd was complete, and the products were exactly 0.82 of mercury and 0.18 of oxygene.

He treated in the same manner red oxyds of mercury prepared in the Dutch manufactories and those which he obtained in his experiments. The proportions of the principles which constitute these oxyds, which are all very brilliant, present but very trifling variations; they amount only to about a hundredth part, so that it may be considered as certain that the crystallised red oxyds of mercury owe this state to a combination of oxygene with the mercury, in which the proportions of the former are constantly from 0.18 to 0.19, whilst such of these oxyds as have no brilliancy contain only from 0.13 to 0.14 at most of this principle.

There result therefore from the preparation of the crystallised red oxyd of mercury two incontestible advantages.

1. The augmentation of the product of this oxyd to the average amount of five *per cent.* more than when it is not brilliant.

2. The impossibility, or at least the great difficulty of fraudulently adulterating this product of art by the admixture of the red oxyd of lead.

Memoir

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Memoir on the Devitrification of Glass, and the Phenomena which take place during its Crystallisation.

By M. DARTIGUES.

From the ANNALES DE CHIMIE.

SOME men of science have considered glass as a crystallisation. This opinion seems a natural one, from the aspect of the transparency of glass or of crystal, since we have borrowed the name of the latter to designate a regular and spontaneous arrangement of the molecules of bodies; but upon farther reflection it is found to be erroneous. In fact, glass never affects a crystalline form, either at its surface or in its fracture; it never presents crystals of its proper substance, such as are remarked in certain metals when properly cooled; and if crystals form themselves in the mass of the glass, they are foreign to the part which is still vitrified; they may be considered as a retrograde step in the vitrification; and this is what I propose to demonstrate in the course of this memoir.

To begin with defining the vitreous fusion, I must distinguish and separate that of the bodies which are fusible by themselves in the heat of our furnaces, such as borax, phosphoric acid, and others. Here, the concentrated caloric softens and fuses substances which, after cooling, retain the transparency and other physical properties of glass which every one knows.

But I must examine and describe the fusion which the vitreous compositions employed for the common purposes of life are made to undergo. In this latter case, the vitrification is the result of a two-fold phenomenon. It is not merely an effect of the accumulated caloric; but it is also produced by the affinity of the substances which en-

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ter into the mixture. These substances, which tend to combine with, and to penetrate each other, exert the laws of their affinities from the moment when they have been raised to a sufficient temperature. It is thus that several earths become fused at a degree of heat in which each of them, if separate, would have changed its state.

Thus the ordinary vitrification is, among substances different and heterogeneous, the result of a combination effected by a high temperature; a result which presents a compound perfectly homogeneous, more or less transparent, elastic, breaking in a peculiar manner, from which is derived the name of *vitreous fracture*; a body in an eminent degree a bad conductor of caloric and electricity, susceptible of being softened by a temperature inferior to that by which it has been fused, and of becoming in it pastey, ductile, &c.

The phenomenon during which all these properties disappear, is what I term *devitrification*. This expression may seem at first an extraordinary one, but it will soon appear to be perfectly correct.

The devitrification has already been surmised by several scientific men; some have even observed it, and remarked several of its circumstances, but in an isolated manner; and I do not know that there has been published upon this fact a series of inquiries capable of affording a clear idea of it, of proving that it is connected with the known properties of all natural bodies, and that it is only the product of a crystallisation.

Reaumur was the first who perceived that glass, especially when it is composed of different earths, as the glass used for bottles generally is, might be decomposed, and lose its transparency and other vitreous properties. Entirely occupied with his labours upon porcellain, Reaumur wished to make the application of this discovery to

the

the fabrication of pottery, and attributed the phenomenon to the substances into which he caused the glass to cement. This fact was termed the *cementation of glass*, and its result *the porcellain of Reaumur*. Nothing could be better calculated for disguising the true theory of the phenomenon than such a denomination.

The labours of Bosc d'Antic upon the same subject had no other end in view than to obtain by this means a good species of pottery, and to discover cements, by the aid of which he might give new properties to this body. Thus, by applying the erroneous term of *cementation* to a phenomenon which in no wise depended upon the action of the substances which were added as cement, those who might be tempted to follow up the series of experiments already made, were led astray. The consequence has been, that Science has gained nothing in this particular since Reaumur: several have equally attempted to cement glass, and have perceived nothing more in the result.

Since then, several persons have observed in glass the property of giving rise to crystallisations; but these observations, made particularly by artists professionally employed in the superintendance of glass-manufactories, have not furnished the consequences which ought to have been deduced from them. The directors of large establishments have rarely leisure to dwell upon the contemplation of small effects; they are obliged to attend to too many things at once. These remarks, though curious in themselves, remained without their application, and no one thought, or ventured to publish, that the crystallisation of glass and the cementation by Reaumur's process, were entirely one and the same thing.

Sir James Hall, in his excellent experiments upon whinstone and lava, discovered the property of these stones

of

of being fusible into glass, and of returning again to the state of stones, according to the circumstances.

He called the latter phenomenon a devitrification; he saw that it was the effect of a precipitation, and explained it in a satisfactory and correct manner; but being too much occupied with deducing from this fact arguments in favour of the Vulcanian geology, he neglected following up what this phenomenon presented of interest to the naturalist. This is the task which I have undertaken, and I shall, in this memoir upon devitrification, present the result of my first researches. As my occupation furnishes me with the means of employing a fire of extreme violence, and continued for whole years, I have had the opportunity to see what not every one is in a condition to observe. The facts which I am about to record in part explain themselves; they are a result of the laws to which all bodies are subjected: all the merit of the observation consists in having seen them in substances, and at times, in which it was not known that these laws were carried into effect.

The bottoms of the ovens in which glass is melted generally exhibit large cavities, hollowed out by the action of the fire and of the corrosive substances which frequently run from the crucibles. These cavities become filled with a species of glass which is called *picadil*. This picadil is the result of the ashes which become vitrified, of the stones of the oven which are fused, and especially of the glass which falls from the pots. Care is taken to draw it out at each melting. When the oven is nearly worn out, the cavities are become so large that they cannot be entirely emptied, and a quantity of picadil remains in them. When the fire is extinguished, this picadil cools extremely slow, being surrounded with some cubic fathoms of masonry, which itself has been penetrated with caloric

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caloric for the space of a year and upwards. I had always remarked, that it was in the glass of these bottoms of ovens that I found crystallisations throughout the mass of the glass, which else was very transparent and pure. These crystallisations, which were always pretty regular and numerous, excited my curiosity, as they had done that of several glass manufacturers before me. I collected a large quantity of them, and carefully chose those which were the most curious, and which presented the most extraordinary characters.

TO BE CONCLUDED IN OUR NEXT.

List of Patents for Inventions, &c.

(Continued from Page 312.)

JOHN HEPPENSTALL, of Doncaster, in the county of York, Machine-maker and Engineer; for improvements in slivering and preparing hemp, flax, and substitutes for hemp and flax, previous to the operation of spinning.
Dated February 5, 1805.

WILLIAM HACKWOOD the younger, of Shelton, in the county of Stafford, Potter; for a method of making windows and lights upon new principles.
Dated February 5, 1805.

JOHN BALL, of the city of Norwich, Engineer; for a machine for thrashing corn and pulse.
Dated February 5, 1805.

JAMES FULLARTON, Surgeon in the Navy; for a diving-machine or apparatus, upon an improved construction, applicable to various useful purposes.
Dated February 5, 1805.

CHRIS-

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CHRISTOPHER PERKINS, of Stockton, in the county of Durham, Builder; for a machine for threshing corn and pulse. Dated February 5, 1805.

JAMES RYAN, of Doonane, in the Queen's county, Ireland, Engineer to the Undertakers of the Grand Canal; for sundry tools, implements, or apparatus for boring the earth for coal, and all kinds of minerals and subterraneous substances, by which the different strata may be cut out in a cheap and expeditious manner, in cores or cylinders, from one inch to twenty inches and upwards in length, and from two inches to twenty inches and upwards in diameter, so as to be taken up entire at any depth that has hitherto been bored; by which, not only the quality of such minerals and substances, but also the declination or dip of the strata, can be ascertained beyond a possibility of mistake; and which tools, implements, or apparatus, are also advantageously applicable to the purpose of sinking for wells, and giving vent to subterraneous water in bogs, and draining mines and grounds, and ventilating pits and other beneficial purposes. Dated February 12, 1805.

CHARLES COE, of the parish of St. Mary Whitechapel, in the county of Middlesex, Baker; for a flue upon an improved construction, applicable to the heating of ovens, or any other thing that requires an uniform heat. Dated February 12, 1805.

WILLIAM MARTIN, of Houghton Pans, in the county of Northumberland, Rope-maker; for a mode of fastening shoes to the feet of men, women, and children. Dated February 19, 1805.

GEORGE DODD, of Great Ormond-street, in the county of Middlesex, Engineer; for improvements on the Royal York gun-lock, other gun-locks, and the locks of all description of fire-arms. Dated February 28, 1805.

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THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. XXXVI. SECOND SERIES. May 1805.

Specification of the Patent granted to JAMES BARRETT, *of Saffron Walden, in the County of Essex, Smith and Ironmonger; for an Improvement in the Construction of Malt Kilns, so as to prevent Damage by Fire, and to save Fuel in the drying of Malt.*

Dated January 29, 1805.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, in the said letters patent contained, I the said James Barrett do hereby declare that my said invention is described and ascertained in manner and form following; reference being made to the drawings hereunto annexed; that is to say: My improvement consists in building kilns agreeably to the drawings, varying their shape, height, and size, as circumstances may dictate, so as to increase the draught, which I introduce sometimes under and sometimes over the neck or furnace of the kiln as well as by the sides; and I generally build the kilns at least ten feet higher than is shewn in the drawing. I in-

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troduce into the barrel or chimney of the kiln an apparatus made of iron, or other fit material, which I denominate an extinguisher, as by its being closed it will totally stop the draught of the kiln, and thereby effectually prevent fire from communicating to the cowl if made of wood, as at present, but which I construct of iron, or other fit metal, and of a peculiar construction, without ribs, or any wood-work whatever; and when circumstances permit, I recommend that the internal windows and doors in the kiln over the wire and their frames be made of iron instead of wood, as it is not subject as wood to shrink, swell, nor warp, by which means the cold external air will be kept out, and the draught of the kiln improved. I construct or build the walls of the kiln hollow or double, so as to leave a space between them. I also apply, according to circumstances, as afterwards is fully explained, apertures, channels, flues, dampers, valves, expellers, dischargers, registers, &c. For the drying of pale malt I make use of a moveable furnace or stove, of a peculiar construction, which may be used with but little alteration of the kiln either for drying pale or brown malt; and by means of an additional contrivance, also hereinafter described, it will burn with advantage Newcastle or pit-coal, without the previous preparation of being burnt into coke, in circumstances where Welch coal or cinders cannot be procured. I also conduct the flame and heat from the furnace through the malt wherever required, without impedient from the wind when blowing hard from either quarter, which I accomplish by means of what I term directors, also hereinafter explained.

Having ascertained generally the nature of my improvement in the construction of malt kilns, so as to prevent damage by fire, and to save fuel in the drying of

malt,

malt, I shall proceed to describe particularly the manner in which the same is to be performed, with reference to the drawings hereunto annexed.

A, Fig. 1, (Plate XVIII.) is an elevation of one side of a malt kiln, next to the kiln-house, constructed according to my improvement.

B B B B B, iron plate and frame, with grooves in the same for the iron doors C C to slide up and down in.

C C, iron doors, which slide over the apertures F, to admit more or less atmospheric air to circulate round the furnace, neck, or receiver D of the kiln, by means of which the air becomes rarefied, and afterwards enters the channels on the right and left (shewn on one side by the letters K and L), which conduct it to, and discharges it at, the apertures *a b* and *c*, shewn in Fig. 3, which is a geometrical view and section, and also in Fig. 4, which is a section of the end of the kiln next the furnace. It is discharged either under or over the wire, tile, hair cloth, or other floor on which the malt is dried, in order to disperse and carry off the vast quantity of steam which always arises in the process of drying malt; and it then may be conducted by means of the registers E, shewn in Figs. 1 and 3, which move on a pivot, either entirely over or under, or partly, in either channel, as the process may require, which will be found particularly advantageous in the process of drying pale malt. G shews half of the iron slide door at the mouth of the furnace; which door is for the purpose of regulating the admission of cold air to the fire, and to prevent it rushing forcibly in, as is the case in kilns now in common use, which materially increases the consumption of fuel. This door is connected to the before-mentioned doors C C, by means of the chains I I I and pullies H H, so that by a single and easy motion of the balance handle M, shewn

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in Figs. 2 and 3, the three side doors C C and C act conjunctively to admit air into the aperture F, and exclude the air from the mouth D of the kiln, they being so contrived and adjusted that no more air is excluded at the furnace than is admitted at the apertures and channels round the kiln and sides thereof; that is to say, as much air is excluded from one place as is at the same time admitted at the other, which tends very materially to the saving of fuel, and carrying off the steam arising from the malt. It also affords the advantage of increasing or decreasing the draught at pleasure to the greatest nicety, and consequently permits the workman to continue his drying in all weathers with ease and safety, which cannot be done in kilns on the old construction, on account of danger from fire. N the iron horse on which the fuel is consumed while drying brown malt.

For the purpose of ventilating the kiln, and rendering it healthful and comfortable for the workmen while they are turning, taking off, or putting on the malt, I make doors to be opened occasionally in hot weather into the channels K and L, but in the drawing one door is only shewn, as at O, the other side exhibiting the channels K L before mentioned. By this means the rarefied air is kept in reserve in the air box under, in the air chamber over, and in the flues round the furnace, and again makes its progress on shutting the said door.

P P are two entrances by double wooden doors leading round the underside of the benches Q, in Fig. 5, by which means the neutral air contained therein repels the damps which otherwise in the kilns now in common use, with solid benchings, is imperceptibly absorbed by the heat of the fire, and which consequently occasions a much greater waste of fuel than is absolutely necessary. I therefore,

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therefore, in cases where new kilns are to be erected, recommend an arch or arches to be constructed under the ash-pit floor.

R, a step ladder or stair case and landing, leading to the entrance S, which opens into the kiln. In Fig. 2 is shewn a sight-hole, to view the progress of the drying without opening the door.

T the barrel or chimney over the kiln.

V the cross bearing beam on which the cowl X, which is made of iron or other fit metal, without ribs or any wood-work whatsoever) turns, with its spindle W, which is also made of iron or other fit material.

Y is the apparatus which I denominate the extinguisher, to prevent damage by fire. It may be made of wood, but more properly of iron or other metal. It is so contrived that by pulling the wire or chain pending therefrom down the side of the kiln, and attached to the handle Z, it will either partially or completely close, at the option of the workman, the barrel or chimney of the kiln, and effectually stop or regulate the draught; and if the wire or chain be continued from the said handle Z down to the fire-side, the workman may in windy weather be enabled to regulate the draught and currency of air at his pleasure with the greatest ease, and extinguish the malt, if on fire, without the necessity of ascending the step ladder or stair case for that purpose, as he can by that means close the extinguisher, which will immediately stop the draught of air that feeds the flames, and of course the fire is suffocated and extinguished by the smoke arising therefrom, and cannot do any farther damage. The workman may therefore, by means of the handle Z and the balance handle M before mentioned, regulate the extinguisher and iron slide doors so as to dry the malt either exceedingly slow or exceedingly fierce,

fierce, as may best suit his purpose, with the same ease that a miller regulates his brake when grinding corn.

Fig. 2 shews the elevation of the front of the kiln, with the moveable furnace in the neck, as used in drying pale malt. The letters refer to similar parts as described under the same letters in Fig. 1.

Fig. 3, geometrical view and section of the kiln, drying-floor, benchings, hurdle, spark plate or defender, and a section of the neck of the kiln, shewing the flues and channels which convey the external air, after being rarefied either under or over the kiln, by means of pipes, flues, or hollow walls, as expressed in Fig. 1.

a, &c. are apertures from the walls, which are double or hollow, for conveying the rarefied air over the malt, in order to dispel or carry off the steam arising therefrom while drying. These apertures are closed next the kiln with open kiln-wire in order to keep out vermin.

b, &c. are apertures for the same purpose, but conveying rarefied air under and through the malt while drying.

c shews one of the apertures or pipes under and over, and by the sides of the neck of the kiln, for equalizing the flame under the spark plate.

d, &c. cylindrical iron pipes, to which is fixed the spiral tube Fig. 12, when it is intended to dry pale malt.

E the handle of the register, described before in Fig. 1.

e, brick partition between the flues adjoining the neck.

f the top of the neck over the furnace, round which the atmospheric air revolves, and becomes rarefied.

B section of the iron frame and sliding doors described in Figs. 1 and 2, which are moved up or down by the balance handle M, with its chain and metallic rope placed immediately over the workman's head, or at any other part where most convenient, by which he may regulate the fire to the greatest possible nicety.

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O neutral air under the benches, explained in Fig. 1, P P.

g g the top side of the said benchings.

h h side walls of the ash-pit.

i the wire, tile, or hair cloth, on which the malt is dried.

k iron hurdle under the said wire, tile, or hair cloth, which was originally invented by my father, who, in the year 1773 fixed one up in a kiln belonging to the late Mr. Jabez Wyatt, common brewer in Saffron Walden, where it now remains unaltered, universally acknowledged by every maltster to be a great improvement in the economy of fuel, and in expediting the process, particularly in high-dried, or commonly called brown or porter malt.

l the spark plate or defender.

m m the walls of the kiln.

Fig. 4 section of the farther end of the kiln opposite the furnace.

d d d air pipes.

m m section of the walls of the kiln.

h h walls of the ash-pit.

g g the benching.

K K, L L, channels for air explained in Fig. 1.

o o floor of the ash-pit.

Fig. 5 ground plan of the kiln, here supposed to be about sixteen by eighteen feet within side the walls.

d d d air pipes.

m m m m m plan of the walls of the kiln.

g g g plan of the walls of the benching.

w, &c. plan of the walls of the air box.

P P plan of the opening of the double doors described in Fig. 1.

O plan of the ash-pit.

Q Q Q the space for neutral air, see Figs. 3 and 4.

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r r two doors, which I call directors, placed on each side, at the farther end of the neck, to be made of cast-iron, or other fit metal, or of earth made into the consistency of brick or fire-stone. They are moveable at pleasure, for equalizing the flame arising from wood in drying brown malt. In kilns on the old construction this object cannot be attained by any skill or labour of the workman.

Figs. 6, 7, 8, 9, 10, exhibit the apparatus of which I have before spoken, called the extinguisher, separated from the barrel or chimney of the kiln, that it may be more clearly understood.

Fig. 6 shews the top of the extinguisher when closed, made with two semi-circular plates of iron, but I have found by experience that it is best to construct them in quadrants, as in Fig. 7, also in Fig. 9, which is shewn open.

Figs. 8, 9, and 10, shew the extinguisher open, when the kiln is at work, to permit the steam and smoke to pass through.

a in all these figures denotes a circular iron frame, in which the iron plates *b* hang.

Note. I do not mean to confine myself to the precise forms here described, as the extinguisher may be constructed of various shapes, and fixed in other situations above the malt, according as circumstances may suggest, my invention consisting in the application of the apparatus.

If the extinguisher be closed when the kiln is not in use, it will protect the kiln wire or hair cloth from damage by the weather or soil from birds.

When the kiln is loaded with pale malt, if the extinguisher be constructed in quadrants, it should at the commencement of the operation be nearly closed by the handle

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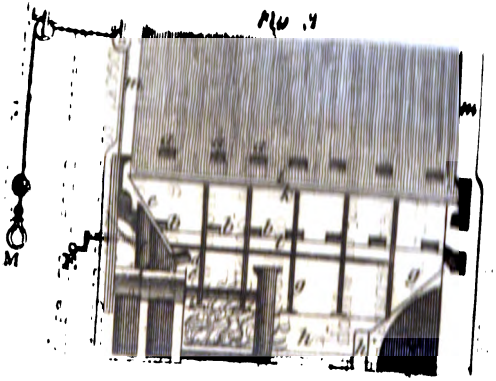

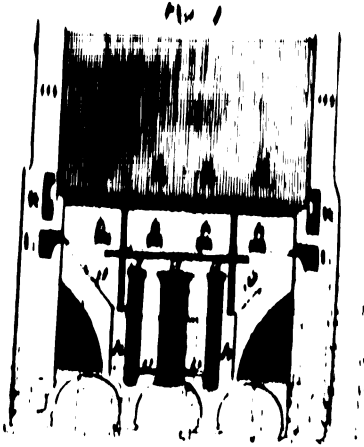

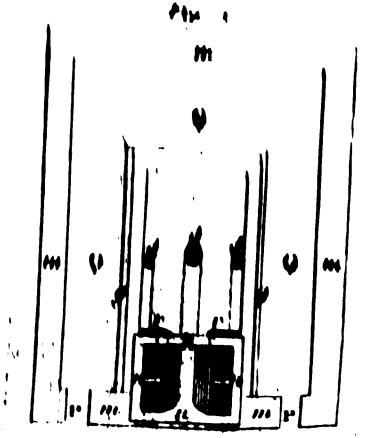

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handle Z, and it will then resemble the flyers of a smoke-jack, and will not only exclude the vast quantity of cold atmospheric air, which otherwise unavoidably enters the kiln at the top of the barrel or chimney, and condenses the vapour which arises from the malt, and thereby keeps the surface thereof in a chilled state (even to the injury of the malt), as the heat which should be gentle cannot immediately penetrate to the surface, particularly if loaded thick; but assists greatly to the generation of heat, so that a very small fire in my newly-invented furnace hereinafter to be described will in a very little time render the malt as hot at top as at the bottom; the whole of the malt will therefore be in a complete state of vegetation, which contributes very much to its tenderness and flavour. The steam or vapour also becomes lighter, and consequently passes off quicker than in kilns without this apparatus. As the steam increases, the extinguisher is to be gradually opened and closed in the same way as the steam or vapour subsides, so that no heat escapes without doing its office.

Figs. 11 exhibits, in perspective and geometrically, my newly-invented moveable stove or furnace for drying pale malt or amber where Welch coal or cinders are used. It runs on four wheels or rollers, and may be set in a kiln either for drying brown or pale malt with but little alteration, as hereinafter described.

It may be regulated by the ash-pit register A, so that in all weathers a due sufficiency of air may be admitted to keep the process of drying in the most regular manner, which in the present constructed kilns cannot be accomplished from the various changes of weather, as a high wind often consumes the fire rapidly in the absence of the workmen, who, on their return, frequently find the fire extinct, and the process of drying ceased, which

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tends to injure the malt both in bulk and flavour. By means of the double door B B to the furnace, the heat is so confined as that considerably less fuel will be required than is consumed in furnaces now in use, which I have ascertained by experience to be a saving of one third. I am indebted to his excellency Count Rumford for this invention, which he has described in his Essays, from which I have acquired much information. Contiguous to the double door B B I have added another door E, above the furnace, which completely closes the whole of the furnace, so that no heat can possibly escape; and as I am confident that the process of drying, to be carried on with advantage, depends on a judicious management of the air and heat, it will be found that this door E, in conjunction with the slides C C, described in Fig. 1, and the apertures F F, through which the atmospheric air passes, will become rarefied, conducted, and discharged as before described. With the same motion that the doors C C, Fig. 1, are opened or slid up, the door G in the same figure will slide down upon the frame of the double doors in Fig. 11, and by this means will form a double door with E alternately, and entirely prevent the escape of the radiant heat.

It sometimes happens that there is a failure in the supply of Welch coals and cinders, on which account I have added a contrivance to this moveable furnace, in order that Newcastle or other pit-coal may be used without the previous preparation of being burnt into coke. This I effect by means of the register F, which closes the farther end of the neck of the kiln, and prevents the smoke arising from pit coals passing into the kiln, which is accomplished by the screw and roller G, with its winch H, at the front of the furnace, so that in this case both ends of the neck are effectually stopped, and the smoke

passes

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passes through the top of the neck by means of the iron pipe I, Fig. 12, round which is a spiral tube, to receive the air which enters the aperture F, in Fig. 1, and its air chambers; and by its revolving round the said pipe so immediately in contact, it becomes sufficiently heated to effect the operation, and the smoke becomes so chilled that what heat remains in the pipes exhausts itself in its passage through a pipe for that purpose under the wire, and empties itself into the communication-pipe Fig. 13, placed within side of the barrel of the kiln, with a conjunctive movement of the valve *a*, or damper *b*, to the ash-pit register A.

Note. I apprehend that this last-described invention will be found of great utility as an addition to the cooking apparatus on the economical principles recommended by Count Rumford, and may also be applied with advantage in manufactories, or other places where boilers or stoves are used. I think proper also to observe, that although I have in this specification only spoken of the drying of malt, it must be evident to every one, that various other commodities may be dried with advantage in kilns erected according to my improvement.

In drying of brown malt it is the particular interest of the malster, and the merit of the workman, to obtain as much increase in bulk as possible, which is principally accomplished by the process of drying; and it is the common observation among workmen, that they could dry the malt higher and larger if it could be protected from the risk of taking fire, and the danger which the workman himself encounters in his endeavours to extinguish the fire whenever it happens, which is very frequent. In this trying situation he is in imminent danger of being burnt, or suffocated to death, and his endeavours are often frustrated. Thus it is in all malting towns

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where brown malt is made, that fires are so frequent, to the terror of the inhabitants; and it is presumed that all these dangers and inconveniences are most effectually done away by my improvement. The workman may now raise or force the malt to any extreme of heat short of actual flame, which is the grand desideratum in the process of drying brown malt.

The extinguisher, slide doors, and channels, may easily be added to kilns already constructed.

In witness whereof, &c.

Specification of the Patent granted to JAMES FUSSELL, *of Mells, in the County of Somerset, Iron-manufacturer; for improved Methods of working Water Wheels, raising of Water, and in a great Measure preventing Water Wheels from being flooded, and other useful Purposes.*

Dated June 14, 1803.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said James Fussell do hereby declare my said invention to be as described in the following specification and drawings annexed, with the references thereto; that is to say: Fig. 1, (Plate XIX.) is a side view of the improved method of working water-wheels. A the water wheel. B two cranks, to return the lever by the same lifters that raise them. C two levers to work the pumps. D D D D lifters. E the buckets fixed to chains, (as shewn in Fig. 6, of which the chain is composed) The chain can be made of any length or strength, according to the depth of the fall of water; for instance, a small spring rising on a hill which has a fall of fifty yards,

more

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more or less, it will be necessary to carry the water in a trench to the steepest part of the hill, in order to have the level as short as possible; which level must be drove to a pit sunk perpendicularly under the wheel, the buckets working over: the wheel may be made small, in order for the buckets to work in a common pit of four or five feet diameter. It is evident there will be, by working water wheels by this method, a great advantage over the present, as the whole weight of the water will always hang at the greatest distance from the centre of the wheel. F the small chain and buckets for raising water, ores, coals, or other bodies from mines, &c. The buckets are hung to the crooks of which the chain is composed; which standards must project a sufficient distance to give the buckets room to turn on pivots, and tip the contents into the receiver L, which are carried off by the level N. The buckets may be hung at any distance from each other, and made to contain any quantity of water, &c. according to the power that is applied. G the rod for working the pump. H trough or trunk which carries the water, and delivers it into the buckets E. I I two boxes, which may be loaded to balance the levers and rods. K wheel to steady the chain that works at the bottom. M the pump. N the lever to carry off the water, &c. O a wheel for the same purpose as at K.

Fig. 2 is a front view of Fig. 1. A, water-wheel. B balance or fly-wheel. C shaft. D D lifters. E buckets and chain, as in Fig. 1. F small chain and buckets, as in Fig. 1. G socket to unite the water wheel shaft with the shaft C. H small wheel, made of cast-iron, or any other metal, lightly fluted on the face, to prevent the chain or crooks from slipping. K wheel for the same purpose as at K in Fig. 1. N lever for carrying off the water, &c. O wheels as in Fig. 1.

Fig.

Fig. 3 an improved method of raising water, by wind, hand, or other power. A, rudder to turn the half circle box B, which covers half of the horizontal wheel C, in order to cover half the wheel that works against the wind. D shaft of the horizontal wheel. E main posts which support the horizontal wheel. G G windlasses to raise the bucket by hand in case the reservoir should fail. H spindle. I small iron wheel, which the chain and buckets pass over. K ratchet wheel, which works in a small nut L, fixed in the upright shaft of the wind wheel. *a* receiver to tip the bucket, and convey its contents into a reservoir *b*, to supply water in case of the winds failing, which will be sometimes the case.

Fig. 4, method to prevent water wheels in a great measure from being flooded. A, hatch to admit the water on the mill wheel. B B B hatches to let in the water to the carriage G, to work on the short ladles or buckets at E and F. C the mill wheel. D the shaft of the wheel that forces the water out of mill wheel.

Fig. 5 front view of Fig. 4. E the long ladle which forces the water of the mill tail. F the large short ladle worked by the great body of water from the pond. D the shaft of the forcing wheel.

Fig. 6 shews the method of making the chains for the machine. Two crooks of which the chain is composed, on a large scale, of which all the chains are made on the same construction.

In witness whereof, &c.

Specification

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Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

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Specification of the Patent granted to BARKER CHIFNEY, *of London, Gentleman; for a Composition to be used in Washing, in order to render Muslins and Linens beautifully white, and also for other Purposes.*

Dated September 14, 1804.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Barker Chifney do hereby declare, that my said new-invented composition is made in the following manner; that is to say: I take of water, or water saturated with lime, twelve parts, or thereabouts, in which, with the assistance of heat, when necessary, I infuse two, three, four, five, or six parts, of what is usually called sub-carbonate of potash or sub-carbonate of soda, or of both of them, according to the purposes for which the said composition is intended. Or otherwise I make my said alkaline solution by any of the usual chemical methods, so that the proportion of water or of lime-water to the alkali or alkalies contained therein shall be such as, upon trial, may be found to produce effects equally suited to the particular uses to which the composition is afterwards to be applied. And to the alkaline liquid when hot in the copper, or otherwise, I add four, five, six, seven, or more parts, of common soap, sliced or macerated, or in such other form as may be best calculated to incorporate it with the whole mass, and afford a compound, having the consistence of cream or butter, or even of tallow or ordinary soap. When the whole composition is sufficiently mixed or incorporated, if in a hot state, I stir it in the copper till cool, or else I transfer it into a back or other vessel and do the same. It is to be observed, that the composition will be strong

or

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or weak in proportion to the purity of the sub-carbonate of potash or sub-carbonate of soda made use of, or of both when made use of together; and that it is therefore necessary to pay attention to this circumstance in particular. And also, that I prefer taking away the sediment of the lime-water and alkali or alkalies when mixed, although I am not certain that any bad effects arise from suffering it to remain.

In witness whereof, &c.

Specification of the Patent granted to JOHN JONES, *of the City of Chester, Chemist; for a Liquor for printing and dyeing of Cotton, Linen, or Woollen.*

Dated January 23, 1805.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso I the said John Jones do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, as follows; that is to say, Take vinegar, pyrolignous or wood, sorrel, tartarum, or any other vegetable acid; saturate it with lime, or any other calcareous earth; let it stand till it has subsided; pour it off clear; heat it over a fire, and put to it as much vitriolic, sulphic, nitric, or marine, salts of lead as will separate the whole of the oily, bituminous, or extractive parts or matter. When they are separated, let it stand till it has subsided; when clear run it off, and put to it as much alum or copperas as will separate the lime and lead, and thus the printing or dyeing liquor is made.

In witness whereof, &c.

Observations

Observations on Basalt, and on the Transition from the vitreous to the stony Texture, which occurs in the gradual Refrigeration of melted Basalt; with some Geological Remarks. In a Letter from GREGORY WATT, *Esq. to the Right Honourable* CHARLES GREVILLE, *V. P. R. S.*

(Concluded from Page 366.)

HITHERTO I have selected instances from substances which have an undisputed claim to an aqueous origin. I shall now, on the authority of Dolomieu, instance a similar arrangement, in a substance respecting the origin of which theorists are not agreed. A species of petrosilex is found in the Val de Nido, in Corsica, which contains radiated petrosiliceous glands, from half a line to an inch in diameter. These glands only differ from the basis by their radiated structure, and their colour; and appear to indicate very clearly, that the rock was subjected to a species of arrangement which, if it had been completed, would have changed its nature, and probably would have rendered it porphyritic; for Dolomieu observes, that the centre of the glands was often occupied by a small crystal of feldspar *. The extraordinary rock called the globular Granite of Corsica, is an analogous instance. It is composed of crystals of hornblende, feldspar, quartz, and mica, in confused aggregation; and in this basis are immersed spheroids, about an inch and a half or two inches in diameter, composed of concentric alternate coats of quartz and hornblende. The centre is principally occupied by hornblende; this is surrounded by a zone of quartz. These spheroids are radiated to the centre. There can be little doubt that this rock is merely the re-

* Dolomieu. Journal de Physique, 1794, p. 260.

sult of interrupted crystallization; and that, if the process of arrangement had continued, this structure would have disappeared, and the whole rock would have resembled the present basis. Hitherto this very singular rock has only been found in detached fragments *.

The admission that solution is not a requisite of crystallization, appears to me an important concession in favour of the aqueous system, which has laboured under very great embarrassment, from the difficulty of dissolving quartz. If a very perfect mechanical suspension be all that is requisite, we may cease to wonder at the almost daily formation of petrified wood, (in which, though crystallization does not actually take place, a very per-

* I shall venture to quote another instance, on the authority of Professor Playfair. "The salt rock in Cheshire, which lies in thick "beds, interposed between strata of an argillaceous or marly stone, "and is itself mixed with a considerable portion of the same earth, "exhibits a very great peculiarity in its structure. Though it forms a "mass extremely compact, the salt is found to be arranged in round "masses, of five or six feet in diameter, not truly spherical, but each "compressed by those that surround it, so as to have the shape of an "irregular polyhedron; these are formed of concentric coats, distin-"guishable from each other by their colour, that is, probably, by the "greater or less quantity of earth which they contain; so that the "roof of the mine, as it exhibits a horizontal section of them, is di-"vided into polygonal figures, each with a multitude of polygons "without it, having altogether no inconsiderable resemblance to a "mosaic pavement. In the triangular spaces without the polygons, "the salt is in coats, parallel to the sides of the polygons." Illustration of the Huttonian Theory, p. 97.

I am informed, that the siliceous deposition of Geyser is at first a porous friable mass, and that the addition of more molecules renders it fibrous; also that, on a farther addition, the fibrous structure disappears, and the whole assumes the compact even texture of chalcedony or flint. If I am not misinformed, a series of specimens, illustrating this transition, existed in the cabinet of the late Dr. Hutton, of Edinburgh.

fect

fect arrangement is indicated, by the intimate union of the siliceous particles,) or of hydrophanous semi-opals in the decomposed serpentine of Mussinet, near Turin, or of chalcedony containing drops of water, in the decomposed basalt of Vicenza.

I have endeavoured to show, that in the crystallizations resulting from igneous fusion, it is not only possible but probable, that the most infusible substances might not be the first to crystallize; and this appears to involve important consequences, for it partly removes one of the greatest difficulties that embarrasses the igneous theory, by explaining the possibility of refractory substances generated by fire being impressed by the forms of more fusible ones. It seems, however, that the same order of arrangement would prevail in substances that were suspended in a fluid medium, as the degrees of attraction would be the same. In either case, the first step by which the arrangement of an apparently homogeneous mass commenced, would probably be the accumulation of particular molecules into little globules. Such seems to have happened in variolites, and other rocks which contain spherical concretions of a different nature from their basis. Still farther advanced is the arrangement of porphyries: the molecules of one species have assumed a regular crystalline form; and sometimes two, or even more varieties of crystals are formed, which remain unmixed in the unarranged basis. If the remaining molecules of that basis are susceptible of crystallization, it may be fairly concluded, that an extension of the process of arrangement would convert the porphyry into granite, or at least into one of the compound aggregates of crystals which constitute the numerous tribes of granites, grünsteins, and sienites; and it seems equally probable that this might be accomplished, whether the mole-

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cules were indebted to a suitable temperature, or to an aqueous medium, for the requisite facility of movement.

The formation of granite and other rocks must however be referred to the ultimate perfection of crystallization, by which all the molecules have been permitted to arrange. Those granites called porphyritic, in which large crystals of feldspar are imbedded in a basis compounded of the ordinary ingredients of granite in small grains, are apparently generated from a menstruum in which the molecules of one species, being greatly predominant in number to the rest, are the first to exercise their polarity, and constitute large crystals, which are afterwards surrounded by smaller ones, resulting from the successive separations of the remaining elementary molecules.

The changes of the substance that led to the foregoing remarks, serve to show that they are not altogether hypothetical; and any proof that may appear deficient seems to be provided by the phenomena exhibited by lavas, in which may be observed every step of the passage from the vitreous to the stony, from that to the porphyritic, and finally to the granitic state. The lava of Lipari, which passes from glass to lava, by the generation of minute globules, may be cited, on the authority of Spallanzani, as an instance of the commencement of the process of arrangement *; and, were not their origin

* Spallanzani, Viaggi ille due Sicilie, Tomo Secondo, page 238. The whole passage, literally translated, stands thus. "This lava has a "basis of feldspar, of a fine and compact grain, a splintery fracture, "rough to the touch, and emitting sparks, like flint, when struck "with steel. It has an ash colour, in some places approaching to a "leaden colour. It is thickly filled with an immensity of little bodies "which would be distinguished with difficulty from the resemblance

still disputed, I might also cite the porphyritic lavas of the Euganean hills. It would appear, that the transition from the stony to the porphyritic state is rapid, for perfectly homogeneous lavas are among the rarest of volcanic products. The porphyritic lavas are most numerous, and it is needless to detail the variations they present. But though the process of arrangement has often only advanced thus far, it has in many instances proceeded much farther, and it is by no means unusual to find the entire basis regularly arranged into crystalline bodies; thus, to cite a well-known instance, in many of the ancient lavas of Somma, large augites are imbedded in a crystalline mass, formed of minute crystals of leucite, together with another crystalline substance, whose nature is not perfectly determined.

The casual occurrence of volcanic glass is no way at variance with this account, as it is sufficiently probable, that some glasses may have a much greater tendency to crystalline arrangement than others possess; and it may not appear extraordinary, that regular crystals should sometimes be generated, even in the glass, as in a mass

"of their colour to that of their basis, were it not for their globular "form. But this lava is joined to a great mass of glass, which forms "a whole with it, without any division or separation between them; "and this lava, which in many places retains its own nature, is in "many other places reduced to glass. Some parts of this glass are "filled with the same little bodies, but other parts are pure glass. "This is in general very compact, has a dead black colour, and breaks "rather into irregular pieces than into undulated fragments, as glass "properly does. Besides, it has I know not what of unctuosity to "the touch, and to the eye, which is not perceptible in the more per- "fect volcanic glasses. It yields sparks with steel, like the lava, but "the lava is wholly opaque, and the glass, at the angles and thin edges, "has considerable transparency. It is only opaque where the globules "are, which appear to be particles of lava."

tor, of daily occurrence in artificial glasses, and in furnace slags.

If the distinction attempted to be shown between igneous fusion and solution be established, it may offer a means of accounting for the abundance of peculiar bodies in lava, which do not exist in other situations, or at least are of extremely rare occurrence. For, if the igneous action decomposes the molecules of the substances on which it operates, there seems every probability that new compounds may result, dissimilar to any substances we are acquainted with. It would appear, that the necessity of imagining an undiscovered stratum abounding in leucites, chrysolites, and augites, may be dispensed with; and as I have endeavoured to show the probability that the most infusible substances will not be the first to crystallize, the penetration of refractory leucites by fusible augites, will cease to be an argument against both being generated in the lava. I may also observe, that the same causes which vary the crystallized bodies resulting from igneous solution, must operate upon the unarranged basis; and that the same rock may be fused into lavas extremely dissimilar, as their varieties must depend on the degree of solution which the fusion has accomplished *.

If the analogy attempted to be shown between the aqueous and igneous formation appear founded, the

* The evidence of the generation of leucites in the lava which contains them, collected by Leopold de Buch and Breislac, and finally acquiesced in by Dolomieu, appears so satisfactory, that it can hardly be deemed presumptuous to assume the point as determined. Neither De Buch nor Dolomieu have been able to convince themselves that the augites were also formed in the lava; but I confess myself entirely unable to appreciate the cogency of their arguments, which seem annihilated by the admission they have made in favour of leucites.

transition

transition from glass to stone can no way affect the great question which has so long divided geologists, about the origin of basalt; for, though it is synthetically demonstrated that basalt may be formed by fire, the converse of that proposition stands supported by strong analogical arguments, and its formation by water must be allowed to be at least equally possible. How far the probabilities derived from the examination of basaltic formations may influence the ultimate decision, is an enquiry in which I shall not now engage; though I cannot avoid recalling to my mind the numerous instances of petrifactions found in basalt, and, as a counterpoise to that observation, the equally numerous instances in which the heat emanating from it appears to have indurated strata, and coaked beds of coal. One remark may be stated here with propriety, as it arises immediately from the experiment which has occasioned these observations. In the ultimate result of that experiment, the arrangement of the molecules was much more perfect than in the original rock. It might be supposed, that a longer continuance of the suitable temperature was afforded it. This, however, could not be, for the mass was only a few feet long, and a few inches thick; the fire was only maintained a day; and the whole was cooled in a week. But the hill of solid basalt, from which the substance operated upon was taken, is several miles long, and several hundred feet high; and, supposing it to have been irrupted in a state of igneous fusion, it must have required months, nay years, for its refrigeration. How then comes it, that the process of crystallization is so little advanced? How comes the confusion of its texture to indicate the very reverse of the tranquillity and perfection of arrangement, which may be fairly assumed as necessarily attending the extremely gradual changes of so immense a mass?

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This objection admits of being obviated, upon the supposition that, in the process of melting, the molecules of the basalt were decomposed; and that the new ones generated were more disposed to crystallize than those whose place they supplied. This explanation is in some degree justified, by the total disappearance of the minute feldspars and hornblende of the basalt; instead of which, the regenerated stone contains thin lamina of crystals, which are probably augites.

I cannot leave this subject without noticing some particulars, in which the process of arrangement described in the early part of this letter, appears to yield a probable explanation of some of the peculiarities of basalt. The general disposition of basalt to divide into globular masses, in decomposing, is too remarkable a fact to have escaped the attention of naturalists; though, as far as I am informed, no satisfactory explication of it has been given. The common effects of decomposition are obviously inadequate; for it is common to see a large block of amorphous basalt separate into numerous balls, after a few months or years exposure to the weather; and, rapid as the process of decomposition has been in the intervening portions, these balls resist its farther progress with uncommon obstinacy. May not this be attributed to the formation of the radiated spheroids, whose occurrence in my experiment I have already mentioned? and may not their greater resistance of weather simply arise from their aggregation being more perfect than that of the incoherent molecules which have filled the intervals between them? Though the radiated structure has disappeared to the eye, these portions of the stone retain the superiority of more perfect internal arrangement; and, if my pigmy experiments could yield spheroids of two inches diameter, there can be no difficulty in supposing that the grand

operations

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operations of nature may produce them of several feet. The separation of the decomposed fragments in concentric coats seems easily explained; for I have already pointed out the facility with which the radii of the spheroids separated at nearly the same distances from their centres, and the form of the fragments which resulted, resembling fragments of bombs *.

If this idea be not considered as entirely divested of plausibility, I may venture to extend the same principle, to account for the wonderful regularity of the prismatic configuration of basaltic columns, and also for their articulations. If we suppose that a mass of fluid basalt has filled a valley to an indefinite depth and extent, the process of arrangement in its particles must be induced by the removal of its heat or moisture, according as its solution is igneous or aqueous. This can only be done by the action of the atmosphere on its upper surface, and by the ground on which it reposes absorbing the heat or moisture from its under surface. From the variations of the atmosphere, its action must be irregular; and, from the perpetual change of the parts in contact with the heated or moist surface, its operations will always be nearly as active as at first, allowance being made for its variations. But the absorption of the ground will be regular, and regularly diminishing in activity, in proportion as the parts near the mass approach nearer to the same temperature, or same moisture, with the mass above; and its absorptions can be carried on by its transmission of heat or moisture

* Even granite, has been frequently observed to affect globular decomposition, and division into fragments of concentric coats. This mode of decomposition extends to so many substances, that Werner has called the formation it seems to indicate "*abgesonderte stücke*," which has been rendered in English *distinct concretions*.

to the solid rocks below. From these considerations it seems evident, that the arrangement of the part of the basalt near the ground will be begun with more energy than can be continued, and that the results will be more slow and regular than the arrangement induced by the perpetual though variable action of the atmosphere. After the first stage in the process of arrangement has been performed, and a stratum, if I may so term it, of the jaspideous substance extended over the surface of the ground, there seems no reason to doubt that a number of radiated spheroids would be generated in it, which would probably have all their centres about the same distance from the ground; and, as the arranging power undergoes a gradual diminution of energy, it is not probable that two rows, in height of them should be formed at once, as that would indicate a hasty process, which had prepared a greater mass of matter for their almost simultaneous formation. From these considerations, there seems no improbability in supposing, that in the arrangement of a mass of basalt, a single layer of radiated spheroids would be formed, reposing on the ground which supported the mass.

I have already stated, that, when the radii of two spheroids came into contact, no penetration ensued, but the two bodies became mutually compressed, and separated by a plane, well defined, and invested with a rusty colour. I also stated, that when several spheroids encountered, they formed one another into prisms with well defined angles. In a stratum composed of an indefinite number in superficial extent, but only one in height, of impenetrable spheroids with nearly equidistant centres, if their peripheries should come in contact on the same plane, it appears obvious that their mutual

action would form them into hexagons; and, if these were resisted below, and there was no opposing cause above them, it seems equally clear, that they would extend their dimensions upwards, and thus form hexagonal prisms, whose length might be indefinitely greater than their diameters. The farther the extremities of the radii were removed from the centre, the nearer would be their approach to parallelism; and the structure would be finally propagated by nearly parallel fibres, still keeping within the limits of the hexagonal prism with which their incipient formation commenced; and the prisms might thus shoot to an indefinite length into the undisturbed central mass of the fluid, till their structure was deranged by the superior influence of a counteracting cause, which would be provided by the action of the atmosphere on the upper surface of the basalt. If this arrangement existed, the same cause that determined the concentric fractures of the fibres of the spheroids, would produce convex articulations in the lower joints of the prisms; and, in proportion as the centre from which they were generated became more remote, the articulations would approximate to planes. If the generating centres were not equidistant, the forms of the pillars would be irregular; and the irregularity would be in proportion to the diversity of distance between the centres. If the difference was great, the number of sides would be altered, and they might be found pentagonal, tetrahedral, and trihedral. As the compression of the fibres would be greatest in the level of the generating centres, the lower part of the prisms would be most compact.

All these conditions seem to be fulfilled, in the actual conformation of basaltic columns; for, in every instance I am acquainted with, they appear to have been formed

in the tranquil bosom of the mass, as they have been originally masked by amorphous trap, and their prismatic structure is only displayed by the removal of this covering. This has been variously effected, sometimes by the apparent disrupture of rocks, sometimes by the exterior portions of the mass being thrown down by the failure of the ground on which it stood, sometimes by the violence of the waves, and not unfrequently by the working of quarries. In most instances, these operations have only removed the covering from one side of the colonnade; and it remains crowned, and generally surrounded, by an immense amorphous mass. Where there are two ranges of columns, with an intervening amorphous stratum, it is probable that the upper is the result of a second inundation of fluid basalt. It is well known that basaltic columns are most solid at the bottom; and their convex articulations have been repeatedly observed. Since these considerations occurred to me, I have had no opportunity of examining, whether the divisions approach nearer to the plane surfaces as they recede from the centre from which the prism was generated, nor whether below that centre the convex surface of the articulations is inverted; but I think it by no means improbable, that subsequent observations may establish this to be the case, and thus confer on this hypothesis nearly all the demonstration of which it is suscepitble. I may however add, that the phenomena of prismatic division in basaltic veins perfectly coincide with what might be inferred from the data upon which my reasoning has proceeded. In veins, it is obvious that the refrigerating or absorbing cause must operate with nearly equal force on each side of the vein; and it follows, that two sets of prisms would be generated, which would be horizontal instead of perpendicular, and

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that, unless a mass of amorphous basalt was interposed between them, they must form a division in the middle of the vein, as from the mutual impenetrability of their fibres they could not incorporate. The coincidence of the existing phenomena with these conclusions is sufficiently remarkable; for, in numerous observations I have made on the basaltic veins which affect the prismatic configuration, I found the prisms were always horizontal, and often, that there were two ranges of them. One of their ends applied to the wall of the veins, the other frequently united to an amorphous mass which separated them; and, when no such intermedium occurred, there was invariably a division in the middle of the vein. Not unfrequently, the veins contain three sets of prisms; a range of small ones on each side, and of much larger ones in the middle. In this case, the little prisms are always separated from the large ones, and the divisions of the large ones are very irregular *.

After the statement of my opinion, that perfect similarity of structure may exist in the products of aqueous and igneous formation, it will hardly be necessary to conclude these observations with remarking, that I should not consider the establishment of these peculiar modes of arrangement as the slightest demonstration of the igneous origin of basalt. It appears to me, that the truth of my deductions is entirely independent of either theory, and that, if ever the period should arrive when the origin of basalt shall be determined by irrefragable

* The observations alluded to were made during the course of last summer, (1803,) on the very numerous basalt veins, or, as they are there called, Whin Dykes, which traverse the red sandstone and red sandstone breccia, which forms the greatest part of the coast of the Firth of Clyde, between Greenock and the Largs.

demonstration,

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demonstration, the inferences I have drawn may be accommodated with equal facility to either mode of agency*.

The immense magnitude of some basaltic columns, the extreme regularity of their prismatic configuration, and the peculiar structure of their articulations, have directed the attention of naturalists to them, much more than to any of the other rocks which affect the columnar form. Yet many of these are sufficiently remarkable to deserve more particular notice than has generally been paid to them; and they afford most illustrative proof, that this configuration is not confined to either the aqueous or igneous formation; for some

* Mr. Keir, in his Paper on the Crystallizations formed in Glass, suggests the probability of basaltic pillars being formed by the crystallization of vitreous lavas. See Philosophical Transactions for 1776, Vol. LXVI. page 530.

Dolomieu was of opinion, that the prismatic form was peculiar to lavas which had flowed into the sea; and he attributed it to the shrinking of the mass: his description of the appearances exhibited by what he calls the prismatic lavas at the foot of Etna merits quotation.

"In the lavas of Etna, the form and dimensions of the columns "vary as much as the manner in which they are grouped; hexaedral and pentaedral prisms are most abundant; then the tetraedral, "the triedral, heptaedral, and octaedral. The least I have seen are "only four inches diameter; others are more than three feet; they are "commonly of a single shoot, which is sometimes 60 feet high; "others are divided by articulations, which are from one to six "feet asunder.

"I have more than once observed a large column divide into several "smaller in its upper part. The columns are generally larger near the "top than the bottom of the stream of lava, because they subdivide; "and they are always least in that part of the stream of lava which "first entered the water, the refrigeration being more prompt, and its "effects more marked. Sometimes the columns are placed perpendicularly side by side, and form vertical walls, which are sometimes more than 100 feet high, and a league long; sometimes they

are

some lavas, universally allowed to be such, are prismatic.* Columns of porphyry are not rare; and, among other

are heaped obliquely, horizontally, and in all positions. Some, without being divided in their length, are larger at one end than the other; and then they are arranged like wood piled up, with all the small ends at one side; sometimes they are formed into pyramidal bundles, by parting from a common centre; and, finally, there are some which, by their reunion, form large balls. These radii of lava, which are rather pyramidal than prismatic, resemble those of the globular pyrites, striated from the circumference to the centre, which are found in the chalk of Champagne.

"On the shore of la Tezza, near the Mole, there is a very curious group of little articulated prisms, which issue from a common centre, and form fasciculi singularly twisted. The articulations are marked, but the species of vertebræ do not separate. In the heart of the mountain on which stands the Castello di Jaci, there are large balls, from two to four feet in diameter, resembling in form the large pyrites in the chalk of Champagne. These balls of lava are formed of pyramidal columns, united by their points in a common centre." *Catalogue des Laves de l'Etna*, page 462.

The division of the upper part of basaltic columns into several smaller ones, has also been observed in the basaltic columns of Fairhead, by Dr. Richardson. See Nicholson's Journal, 4to. Vol. V. page 321.

* Almost all the prisms at the foot of Etna, described by Dolomieu, are of dubious origin; most of them are probably basalt. The columns of Vicentine are of the same substance, and so are the prismatic lavas of Auvergne, and of the Vivarais. The bed of lava at la Scala, near Portici, is divided by vertical fissures, which give it the aspect of irregular columns. At Aquapendente, in a quarry of undoubted lava, near the road, are some much more perfect prisms; but the most beautiful I have seen are the small ones from Ponza. The columns at Bolsena are said to be basalt. Those of the Euganean hills are very irregular in form; in their texture they are certainly wholly unlike granite, which Mr. Strange thought they resembled. I believe them to be lava.

The mention of some columnar formations that follow is by no means intended as an enumeration of them. I have confined myself to those which I have either inspected in their natural situation, or of which I have seen numerous specimens.

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places, are found near Dresden, several feet in length, and not more than two inches in diameter. Columns of petrosilex compose a large portion of a mountain near Conistone lake. Very perfect quadrangular prisms of argillaceous schistus are found near Llanwrst. Rubble slate assumes the columnar form at Barmouth. The limestone near Cyfartha, in Glamorganshire, is divided into very regular acute rhomboidal prisms: even the sandstone of the same district is not unfrequently columnar; and one of the beds of gypsum at Montmartre is distinctly divided into pretty regular columns. Sandstone, clay, argillaceous iron ore, and many other substances, become prismatic by torrefaction; and the prisms of starch formed in drying have often been considered as illustrative of basaltic formations.

I am very far from conceiving, that all these configurations are influenced by such systematic arrangements as have determined the form of some basaltic columns. I consider most of them as solely attributable to contraction; which is only a farther extension of the aggregative force, and must be regulated by the texture, the form, and the position of the mass. Where the texture of the mass is homogeneous, and its contractions uniform, its dimensions may be diminished, without its continuity being destroyed, provided its aggregation be so strong as to overcome the *vis inertiæ* of the mass, and its adhesion to other substances. But, when the resistance is sufficient to overcome the aggregation, the mass will be rent by fissures perpendicular to the direction in which the greatest resistance to its contraction takes place, or, in other words, by fissures perpendicular to its greatest surface; for it is from the extremities of the greatest surface, that the largest quantity of matter must traverse the greatest space,

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in order that the contraction may be performed without breach of continuity; therefore, if it be an extensive tabular mass, it will be divided into prisms, by fissures perpendicular to its surfaces. The power of aggregation would determine these prisms to be hexagonal, as that form contains the greatest quantity of matter in the least surface, of any prisms that can be united without interposing prisms of other forms. But this would require the texture, the contraction, the thickness of the mass, and its adhesion to surrounding substances, to be every where precisely the same; and, as these conditions can never be fulfilled in an extensive formation, all the irregularities that are found must necessarily ensue. The same rule that determines the fissures of a tabular mass to be perpendicular to its surfaces, must determine the rents in a spheroid to be directed from its periphery to its centre.

Though these considerations may be sufficient to explain the tendency to division into prisms, which is so generally extended, and which has produced many of those abortions that have been dignified with the name of columns, because they have occurred in lavas and in rocks of trap formation, they are utterly inadequate to illustrating the formation of the more perfect basaltic prisms: they offer no means of accounting for the extreme regularity of the sides and the precision of the angles, for the articulations, for the close contact in which the perfect columns are placed to one another, nor for their mutual adhesion, which is so strong, that it often requires considerable violence to separate them. These facts are in absolute contradiction to all idea of retreat or contraction, and seem to me to coincide perfectly with the explanation of their origin which I have already presumed to lay before you.

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Method of suspending Ships instead of lifting them, for the Purpose of clearing them from their Blocks.

By Mr. ROBERT SEPPINGS, *of Chatham Yard.*

With a Plate.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Gold Medal was voted to Mr. SEPPINGS *for this Invention.*

THE following is a description of an invention, by Mr. Robert Seppings, late master shipwright-assistant in his Majesty's yard at Plymouth, (now master shipwright of his Majesty's yard at Chatham,) for suspending, instead of lifting, ships, for the purpose of clearing them from their blocks; by which a very great saving will accrue to the public; and also two-thirds of the time formerly used in this operation. From the saving of time another very important advantage will be derived, that of enabling large ships to be docked, suspended, and undocked, the same spring-tides. Without enumerating the inconveniencies arising, and perhaps injuries which ships are liable to sustain, from the former practice of lifting them, and which are removed by the present plan; that which relates to manual labour deserves particular attention; twenty men being sufficient to suspend a first-rate, whereas it would require upwards of 500 to lift her. The situation which Mr. Seppings held in Plymouth yard attached to him, in a great degree, the shoring and lifting of ships, as well as the other practical part of the profession of a shipwright. Here he had an opportunity of observing, and indeed it was a subject of general regret, how much time, expense, and labour, were required in lifting a ship,

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ship, particularly ships of the line. This induced him to consider whether some contrivance could not be adopted to obviate these evils. And it occurred to him, that if he could so construct the blocks on which the ship rests, that the weight of the ship might be applied to assist in the operation, he should accomplish this very desirable end. In September, 1800, the shoring and lifting the San Josef, a large Spanish first-rate, then in dock at Plymouth, was committed to his directions; to perform which, the assistance of the principal part of the artificers of the yard was requisite. In conducting this business, the plan, which will be hereafter described, occurred to his mind; and from that time, he, by various experiments, proved his theory to be correct: the blocks constructed by him, upon which the ship rests, being so contrived, that the facility in removing them is proportionate to the quantity of pressure; and this circumstance is always absolutely under command, by increasing or diminishing the angle of three wedges, which constitute one of the blocks; two of which are horizontal and one vertical. By enlarging the angle of the horizontal wedges, the vertical wedge becomes of consequence more acute; and its power is so increased, that it has a greater tendency to displace the horizontal wedges, as can be proved by a model *, where the power of the screw is used as a substitute for the pressure of the ship.

Mr. Seppings caused three blocks to be made of hard wood, agreeable to his invention, and the wedges of various angles. The horizontal wedges of the first block were nine degrees, of the second seven, and of the third five; of course the angle of the vertical wedge of the first block was 162 degrees, of the second 166, and of

* Preserved in the Society's repository for public inspection.

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the third 1770. These blocks or wedges were well executed, and rubbed over with soft soap for the purpose of experiment. They were then placed in a dock, in his Majesty's yard at Plymouth, in which a sloop of war was to be docked; on examining them after the vessel was in, and the water gone, they were all found to have kept their situations, as placed before the ship rested upon them. Shores in their wake were then erected to sustain the ship, prior to the said blocks being taken from under the keel. The process of clearing them was by applying the power of battering-rams to the sides of the outer ends of the horizontal wedges, alternate blows being given fore and aft, by which means they immediately receded, and the vertical wedges were disengaged. It was observed, even in this small ship, that the block which was formed of horizontal wedges of nine degrees came away much easier than those of seven, and the one of seven than that of five. In removing the aforesaid blocks by the power of the battering rams, which were suspended in the hands of the men employed, by their holding ropes passed through holes for that purpose, it was remarked by Mr. Seppings, that the operation was very laborious to the people, they having to support the weight of the battering-rams, as well as to set them in motion. He then conceived an idea of affixing wheels near the extremity of that part of the rams which strikes the wedges. This was done before the blocks were again placed; and it has since been found fully to answer the purpose intended, particularly in returning the horizontal wedges to their original situations, when the work is performed for which they were displaced, the wheels also giving a great increase of power to the rams, and decrease of labour to the artificers; besides which, the blows are given with much more exactness. The same

blocks

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blocks were again laid in another dock, in which a two-decked ship of the line was docked. On examination, they were found to be very severely pressed, but were removed with great ease. They were again placed in another dock, in which a three-decked ship of the line was docked. This ship having in her foremast and bowsprit, the blocks were put quite forward, that being the part which presses them with the greatest force. As soon as the water was out of the dock, it was observed, that the horizontal wedges of nine and seven degrees had receded some feet from their original situations. This afforded Mr. Seppings a satisfactory proof, which experience has since demonstrated, (though many persons before would not admit of, and others could not understand, the principle,) that the facility of removing the blocks or wedges was proportionate to the quantity of pressure upon them. The block of five degrees kept its place, but was immediately cleared, by applying the power of the battering-rams to the sides of the outer ends of the horizontal wedges. The above experiments being communicated to the Navy Board, Mr. Seppings was directed to attend them, and explain the principle of his invention; which explanation, farther corroborated by the testimonials of his then superior officers, was so satisfactory, that a dock was ordered to be fitted at Plymouth under his immediate directions. The horizontal wedges in this, and the other docks that were afterwards fitted by him, are of cast-iron, with an angle of about five degrees and a half, which, from repeated trials, are found equal to any pressure, having in no instance receded, and when required were easily removed. The vertical wedge is of wood, lined with a plate of wrought iron, half an inch thick. On the bottom of the dock, in the midst of each block, is a plate of iron three quarters of

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an inch thick, so that iron at all times acts in contact with iron.

The placing the sustaining shores, the form and size of the wedges and battering rams, &c. also the process of taking away, and again replacing, the wedges of which the block is composed, are also exemplified by a model.

The dock being prepared at Plymouth, in August, 1801, the Canopus, a large French eighty-gun ship, was taken in, and rested upon the blocks; and the complete success of the experiment was such, that other docks were ordered to be fitted at Sheerness and Portsmouth dock-yards under Mr. Seppings's directions. At the former place a frigate, and at the latter a three-decked ship, were suspended in like manner. This happened in December, 1802, and January 1803; and the reports were so favourable, as to cause directions to be given for the general adoption of these blocks in his Majesty's yards. This invention being thought of national consequence, with respect to ships, but particularly those of the navy, government has been pleased to notice and reward Mr. Seppings for it.

The time required to disengage each block is from one to three minutes after the shores are placed; and a first-rate sits on about fifty blocks. Various are the causes for which a ship may be required to be cleared from her blocks, *viz.* to shift the main keel, to add additional false keel, to repair defects, to caulk the garboard seams, scarples of the keel, &c. Imperfections in the false keel, which are so very injurious to the cables, can in the largest ship be remedied in a few hours by this invention, without adding an additional shore, by taking away blocks forward, amidships, and abaft, at the same time; and when the keel is repaired in the wake of those blocks,

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by returning them into their places, and then by taking out the next, and so in succession. The blocks can be replaced in their original situations, by the application of the wheel battering-rams to the wedges, the power of which is so very great that the weight of the ship can be taken from the shores that were placed to sustain her. There were one hundred and six ships of different classes lifted at Plymouth dock-yard from the 1st of January, 1798, to the 31st of December, 1800, and had the operation of lifting taken less time the number would have been very considerably increased; for the saving of a day is very frequently the cause of saving the spring-tide, which makes the difference of a fortnight. The importance of this expedition in time of war cannot be sufficiently estimated.

This invention may be applied with great advantage whenever it is necessary to erect shores to support any great weights, as, for instance, to prop up a building during the repair of its foundation, &c. Captain Wells, of his Majesty's ship Glory, of 98 guns, used wedges of Mr. Seppings's invention for a fid of a top-gallant mast of that ship. In 1803 the top-gallant masts of the Defence, of 74 guns, were fitted on this principle by Mr. Seppings; and, from repeated trials, since she has been cruizing in the North Sea, the wedge fids have been found in every respect to answer.

But it is Mr. Seppings's wish that it should be understood, that the idea of applying his invention to the fid of a top-gallant mast originated with Captain Wells, who well understood the principle, and had received from him a model of the invention.

When it is required to strike a top-gallant mast, the top ropes are hove tight, and the pin which keeps the horizontal wedges in their place is taken out by one man

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going aloft for that purpose; the other horizontal wedge is worked in the fid, as shewn in the drawing and model that accompany this statement. The upper part of the fid hole is cut to form the vertical wedge. The advantage derived from fidding top-gallant masts in this way is, that they can be struck at the shortest notice, and without slacking the rigging, which is frequently the cause of springing and carrying them away, particularly those with long pole heads. The angle of the horizontal wedges for the fids of masts should be about twenty degrees.

The above account was accompanied with certificates from Sir John Henslow, surveyor of the navy; Mr. M. Didram, master shipright of Portsmouth-yard; and Mr. John Carpenter, foreman of Sheerness dock-yard, confirming Mr. Seppings's statement.

Reference to the Engraving of Mr. Seppings's Method of obviating the Necessity of lifting Ships, Plate XX.

This plan and section of a seventy-four gun ship describes the method of obviating the necessity of lifting ships, when there may be occasion to put additional false keels to them, or to make good the imperfections of those already on; also when it may be necessary to caulk the garboard seams, scarples of the keel, &c. by which means a very considerable part of the expense will be saved, and much time gained. The blocks are cleared and again returned by the following process. A sufficient number of shores are placed under the ship to sustain her weight, and set taught, stationed as near the keel as the working of the battering-rams fore and aft will admit.

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Avoid placing any opposite the blocks, as they would in that case hinder the return of the wedges with the battering rams. A blow must then be given forward on the outer end of the iron wedges with the battering-rams in a fore and aft direction, which will cause them to slide aft, as shewn in the plan. The battering-rams abaft then return the blow, and the wedges again come forward; by the repetition of this operation, the wedges will be with great ease cleared, and the angular block on the top will drop down. When the work is performed, the blocks must be replaced under the keel, and the wedges driven back by working the rams athwart-ships, as described in the section.

N. B. In returning the iron wedges, to avoid straining the angular blocks, it is proposed to leave a few of them out forward and aft, and stop the ship up, by laying one iron wedge on the other, as shewn at Fig. 1, Plate XX.

To facilitate the business, blocks may be cleared forward and aft at the same time sufficient to get in its place one length of false keel. If the false keel should want repairing, it may be done without any additional shores, by clearing one block at a time, and when the keel is repaired in the wake of that block, return the wedges as above directed, and clear the next, &c.

SECTION and PLAN, Plate XX. Fig. 2.

A, keelson.
B, ceiling.
C, floor timber.
D, dead or rising wood.
E, plank of the bottom.
F, keel and false keel.
G, angular blocks with a half-inch iron-plate bolted to them.

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H, cast-iron wedges.

I, iron plate of three-fourths of an inch thick on the bottom of the dock.

K, battering rams, with wheels and ropes for the hands.

L, cast-iron wedges, having received a blow from forward.

M, shores under the ship to sustain her weight.

Fig. 3 represents part of a top-gallant mast fitted with a wedge fid.

a, top-gallant mast.

b, Fid, with one horizontal wedge worked on it.

c, moveable wedge, with the iron strap and pin over it, to keep it in its situation.

d, trussel trees.

Account of the Processes for dyeing the beautiful Reds on the Coromandel Coast.

Communicated by J. MACHLACHLAN, *Esq. of Calcutta.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal and Ten Guineas were voted to Mr. MACHLACHLAN *for this Communication.*

THE following receipts for dyeing the beautiful reds of the Coromandel Coast were sent to me from Madras by a scientific friend, who had the several operations detailed in them performed in his own presence. I forwarded a copy of them, and a small quantity of the ingredients mentioned in them, to a friend at home, several years ago; but he dying about or soon after the time of their arrival, I never learned what became of them. It strikes me, however, that there is a considerable coincidence between the thread process and that which I have seen recom-

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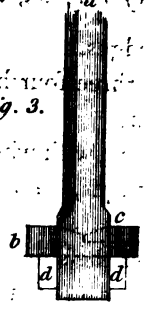
Fig. 3.



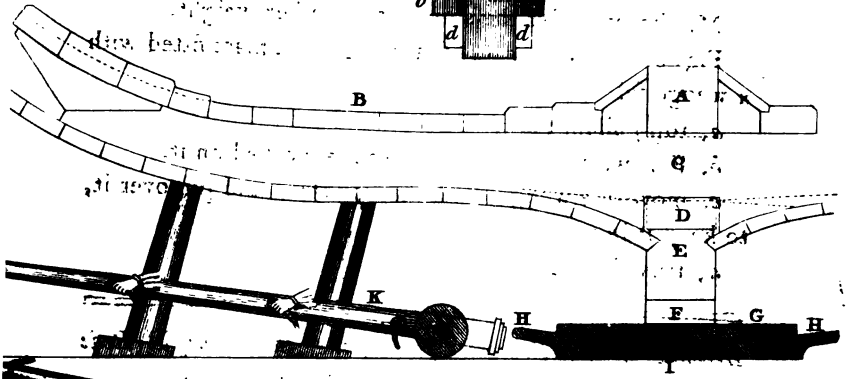


Fig. 2.

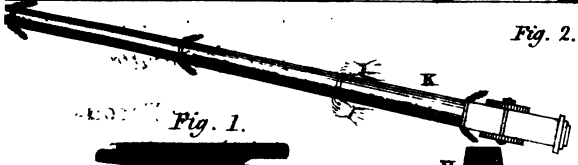
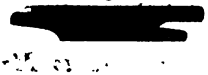
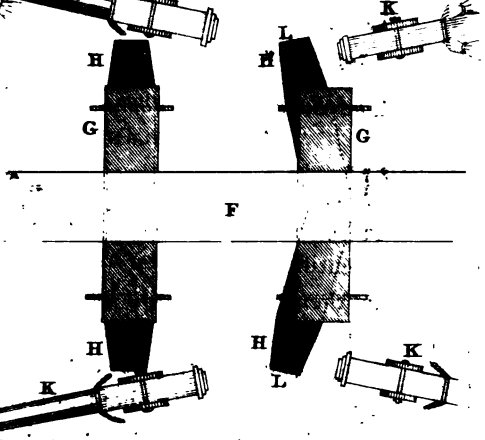
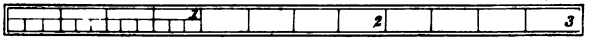


Fig. 1.







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recommended by Mr. Henry, of Manchester, for dyeing the Adrianople or Turkey red.

I am not certain whether it is known at home that many of the hills in Bahar, and other parts of India, contain immense quantities of mica, talc, or Muscovy glass. The natives of this country and China make very splendid lanterns, shades, and ornaments of it, tinged of various fanciful colours; and it is also used by them in medicine. When burned or calcined, it is, I am told, considered as a specific in obstinate coughs or consumptions. When powdered, it serves to silver the Indian paper, &c. used in letter-writing; and, in fact, it is applied to numberless purposes. The bazar price of that of the best quality, split into sheets of about two lines thick, is six rupees the maund of 84 lb. avoirdupois. If it could be applied to any useful purpose at home, it might go in part ballast of ships, and at a trifling expense.

N. B. The chaya, or red dye root of the coast, is, I believe, known at home; as also the cashaw leaves, which are used as an astringent.

Directions for dyeing a bright Red, four Yards of ¾ Broad Cotton Cloth.

1st. The cloth is to be well washed and dried, for the purpose of clearing it of lime and congee, or starch, generally used in India for bleaching and dressing cloths; then put into an earthen vessel, containing twelve ounces of chaya or red dye root, with a gallon of water, and allow it to boil a short time over the fire.

2d. The cloth being taken out, washed in clean water, and dried in the sun, is again put into a pot with one ounce of myrabolans, or galls coarsely powdered, and a gallon of clear water, and allowed to boil to one half: when cool, add to the mixture a quarter of a pint of

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buffalo's milk. The cloth being fully soaked in this, take it out, and dry it in the sun.

3d. Wash the cloth again in clear cold water, and dry it in the sun; then immerse it into a gallon of water, a quarter of a pint of buffalo's milk, and a quarter of an ounce of the powdered galls. Soak well in this mixture, and dry in the sun. The cloth, at this stage of the process, feeling rough and hard, is to be rolled up and beetled till it becomes soft.

4th. Infuse into six quarts of cold water six ounces of red wood shavings, and allow it to remain so two days. On the third day boil it down to two-thirds the quantity, when the liquor will appear of a good bright red colour. To every quart of this, before it cools, add a quarter of an ounce of powdered allum; soak in it your cloth twice over, drying it between each time in the shade.

5th. After three days wash in clean water, and half dry in the sun; then immerse the cloth into five gallons of water, at about the temperature of 120 degrees of Fahrenheit, adding 50 ounces of powdered chaya, and allowing the whole to boil for three hours; take the pot off the fire, but let the cloth remain in it until the liquor is perfectly cool; then wring it gently, and hang it up in the sun to dry.

6th. Mix intimately together, by hand, about a pint measure of fresh sheep's dung with a gallon of cold water, in which soak the cloth thoroughly, and immediately take it out, and dry it in the sun.

7th. Wash the cloth well in clean water, and spread it out in the sun on a sand-bank (which in India is universally preferred to a grass-plat) for six hours, sprinkling it from time to time, as it dries, with clean water, for the purpose of finishing and perfecting the colour, which will be of a very fine bright red.

Directions

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Directions for dyeing of a beautiful Red eight Ounces of Cotton Thread.

1st. Put one gallon and a half, by measure, of sapu wood ashes, into an earthen pot, with three gallons of water, and allow the mixture to remain twenty-four hours to perfect it for use.

2d. Put the following articles into an earthen pot, *viz.* three quarters of a pint of Gingelly oil; one pint, by measure, of sheep's dung, intimately mixed by hand in water; two pints of the above ley. After mixing these ingredients well, pour the mixture gradually upon the thread into another vessel, wetting it only as the thread, by being squeezed and rolled about by the hand, imbibes it, continuing to do so until the whole is completely soaked up, and allow the thread to remain in this state until next day.

3d. Take it up, and put in the sun to dry; then take a pint and a half of ash-ley, in which squeeze and roll the thread well, and allow it to remain till next day.

4th. Squeeze and roll it in a like quantity of ash-ley, and put it in the sun to dry; when dry, squeeze and roll it again in the ley, and allow it to remain till next day.

5th. Let the same process be repeated three or four times, and intermit till next day.

6th. Ley the thread once, as the day before, and when well dried in the sun prepare the following liquor: one gill of Gingelly oil, one pint and a half of ash-ley; in this squeeze and roll the thread well, and leave it so till next day.

7th. Repeat the process of yesterday, and dry the thread in the sun.

8th. The same process to be repeated.

9th.

9th. First repeat the ash-ley process three or four times, as under the operations 3, 4, 5, and then prepare the following mixture: one pint of sheep-dung water, one gill of Gingelly oil, one pint and a half of ash-ley; in this squeeze and roll the thread well, and dry it in the sun.

10th. Repeat the same process.

11th. Do. Do.

12th. Do. Do.

13th. Do. Do.

14th. Do. Do.

15th. Wash the thread in clean water, and squeeze and roll it in a cloth until almost dry; then put it into a vessel containing a gill of powdered chaya root, one pint by measure of cashan leaves, and ten pints of clear water; in this liquor squeeze and roll it about well, and allow it to remain so till next day.

16th. Wring the thread, and dry it in the sun, and repeat again the whole of the 15th process, leaving the thread to steep.

17th. Wring it well, dry it in the sun, and repeat the same process as the day before.

18th. Do. Do.

19th. Do. Do.

20th. Wring and dry it in the sun, and with the like quantity of chaya root in ten pints of water, boil the thread for three hours, and allow it to remain in the infusion until cold.

21st. Wash the thread well in clear water, dry it in the sun, and the whole process is complete.

A singular

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A singular Instance of the Solubility of carbonaceous Matter, and a new Method of forming a black Pigment, having all the Properties of Indian Ink; discovered by Mr. J. W. Boswell.

Communicated in a Letter to the Editors.

Gentlemen,

A CONSIDERABLE time ago, trying some experiments with a different view, I chanced to discover the composition which I now send an account of for your valuable publication. It has all the properties of Indian ink, possessing the same transparency of colour, and the capability of producing a variety of shades; from which circumstance, and its consisting of animal matter, which I have been informed is also discovered in the analysis of Indian ink, there is reason to think that if it is not the same composition exactly, at least it differs but little from it.

Process to obtain the black Pigment.

Take soap-makers lie, (or other caustic alkali in solution,) make it boil on the fire, and add as much horn-shavings as it will dissolve; when the lie is saturated with the animal matter, put in no more, but continue it on the fire after all moisture is evaporated, stirring it with an iron rod till the mass assumes a sort of fusion, and feels like a paste under the rod; for this latter part of the operation a strong heat is necessary. Then remove the matter from the fire, and throw it into water, about double the quantity of the original lie; stir it well, and let it dissolve for some hours. Then filter the liquor from the insoluble matter, and you will obtain a transparent fluid, clear

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clear as rock water, and perfecly colourless. Into this clear liquor drop a solution of alum by degrees: a black precipitate will be instantly thrown down, which, separated from the liquor and dried, and afterwards ground with gum water, produces a black pigment, possessing the properties before mentioned.

The depth of the colour is injured by too much alum, therefore care should be taken to put in no more than what will throw down all the black substance. It appears to me that vitriolic acid would have the same effect as alum, without risking the above accident.

It is a singular circumstance, deserving notice, in this process, that a liquor holding so much carbonaceous matter in solution as that described should be so very clear and colourless; and gives reason to suppose that carbon may be contained in liquors which are not supposed to have any, and also that it may be made soluble in water to a greater degree than is generally imagined; which last may tend to account for the manner in which this substance enters into the vessels of vegetables along with the water which they absorb.

The species of filter, formed by slips of linen laid over the edge of the basin which held the liquor, was what was used in the experiment: it is easily prepared, and none will cause the liquor to descend more clear.

I am, Gentlemen,

Your very humble servant,

J. W. Boswell.

Mercer

Memoir on the Devitrification of Glass, and the Phenomena which take place during its Crystallisation.

By M. DARTIGUES.

(Concluded from Page 391.)

BY comparing the specimens which I had collected, and the circumstances under which they had been formed; by remarks, trials, and experiments, to imitate these crystallisations at pleasure; I was soon enabled to distinguish different classes of them, all of which are produced by the nature of the different substances, which enter into the composition of the glasses. Of these I shall take a hasty survey. I do not, however, intend to speak here of the devitrification which almost always takes place in the scoria of the furnaces of forges: every one must have had occasion to observe it, and will be able to account for it from what I am about to say.

The first remark that presents itself is, that the greater the number of substances which enter into the composition of a glass, the more susceptible it is of being devitrified easily and speedily; but in the same manner as a solvent charged with a large quantity of saline substances of different kinds suffers them to crystallize more confusedly, so also it is not in these glasses that the most regular crystallisations are to be observed. A precipitation takes place in the whole mass; each of the components obeys the laws of affinity at the same time; the transparency soon vanishes, and in a short time a stone only is to be seen, instead of a vitreous body. Such is the manner in which bottle-glass comports itself in its devitrification, which approaches nearly to the nature of the entirely earthy glasses, as there enters but very little salt into its composition.

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Every one has it in his power to hold a common bottle of black glass to a fire continued for a long time, and capable of softening its substance. It soon changes its colour; it becomes grey, and assumes the appearance of stone-ware. This is the porcellain of Reaumur; but it is evident that there is nothing here that resembles cementation.

Now, if instead of observing the phænomenon upon so small a mass, I examine the bottoms of the glass-house ovens where these bottles are made, I find that the glass has been entirely devitrified; that it has even assumed an appearance so extremely similar to that of stone, that the most experienced eye can scarcely distinguish the brick of which the oven was constructed, from the part which has been glass. It is only by following the progress of the devitrification in the less advanced pieces, that we are enabled to discover the glass in a granulated stone, which has more the appearance of stone-ware or clay strongly baked.

Frequently a cooling, continued for an hour or two, is sufficient to effect the entire devitrification of bottle-glass. I have some pieces about eight centimetres in thickness, which I collected in M. Saget's glass-manufactory at La Garre. When a pot has been taken from the oven for the purpose of being repaired, the glass which remained at the bottom of this pot has been preserved from cooling during the time that the pot has been put to cool itself, and this glass has been so changed in its nature as to be nothing more than a mass of crystals composed of small needles converging towards common centres. It has not retained any appearance of vitrification.

This fact shews with what facility bottle-glass is devitrified, and always without the slightest appearance of cementation.

The

The infinite variety of substances which are employed in the composition of bottle-glass, greatly changes the phenomena which take place during its devitrification, and must undoubtedly also have much influence upon the form of the crystals; but I have not had much opportunity to observe this kind of glass.

Passing therefore to glasses of a less earthy nature, and composed of a smaller number of substances, if I in like manner examine the bottoms of the ovens where the half-white glass, called Alsace glass, is made, into which there enters more pure silex and alkali to fuse it, I observe nearly the same phenomena; but as they are less rapid, it is more easy to seize and distinguish them. At the first instant, and in the pieces where the devitrification commences, it appears as if a small quantity of blue colour were diffused in a greenish liquid.

Let me here be permitted to notice a very singular fact, which I shall merely indicate, as I intend to examine it more particularly in another memoir. This greenish glass, mixed with blue, appears to have become of a dirty blue colour when it is viewed opposite to the light; but if we place it between the eye and the light, it always appears greenish, so that it only reflects the blue and refracts the greenish colour.

Continuing to observe the devitrification of the half-white glass, we soon see the blue precipitation followed by another more abundant one, which gives the dirty white, and is very distinct from the first. This last acquires a darker and darker colour, till at length it resembles grey horn.

In these different changes, the substance of the glass appears always to exist; we perceive its polish, its fracture, and all its other properties, except its transparency; but in the midst of this substance, resembling horn, are

formed very distinct crystallisations. These are nuclei, composed of small needles, all converging towards the centre. In this state there is no more glass: it is a crystal possessing all the physical properties of the mineral substances left to themselves.

An accurate analysis of a certain number of these crystals, carefully detached from the mass, may indicate their nature, and afford us more light respecting their formation.

It frequently happens, that these crystallised nuclei are inveloped with a crust, which seems extraneous to their nature, and which might be compared to the incrustation with which the pebbles of silex are covered in the beds of chalk where they appear to grow.

Such is the series of phenomena which the devitrification of the half-white glass presents, when it takes place slowly; but if it be too much accelerated, these phenomena coincide with those which we may observe in the bottle-glass. The half-white glass of which we have just been treating, is that into which no other earthy substance is put besides wood-ashes. It may then have infinite varieties, according to the different compositions.

White glass is very difficult to be brought to crystallise or to be devitrified. When it is well made, it may even be asserted that the long-continued application of fire does not alter it; but, in order that this may be the case, it is necessary that there should enter nothing into its composition but silex, and just the quantity of flux which is required for its saturation. Then the application of fire continued for the greatest possible length of time produces no other change in the glass than to turn it yellow, and harden it.

When the white glasses contain a certain quantity of neutral salts or of tallow, which the fire has not had time or force sufficient to dissipate, there frequently results, during

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during a slow refrigeration, what is called grease, bubbles, and stones, which are formed spontaneously and suddenly.

These accidents, their different causes, and the remedies by which they are to be obviated, I have treated of at large upon a former occasion, in speaking of the melting of glass; but though the explanation of these facts belongs entirely to the theory of devitrification, I think it will here be sufficient for me to consider the phenomena which arise from the presence of the different earths.

The white glasses contain more or less lime, for reasons which I have formerly stated in speaking of the different compositions of glass. This lime, when it is in excess, crystallises very well, as Loysel remarks. These crystals are very easy to be distinguished; they are in such abundance as totally to destroy the transparency. They are prisms which seem to swim in the midst of the paste of the glass, and they tend to collect in it into stars of different configurations. These prisms are all nearly of the same thickness, and two or three millimeters in length. When this crystallisation takes place of itself in large masses at the bottom of the ovens, the colour of the glass becomes deeper, inclining to the black, owing to the presence of a certain quantity of ashes which mix with it. The striated stars of which I have been speaking become the more numerous the greater their distance from the part which is in contact with the fire. Soon these crystallisations, which at first are isolated, are succeeded by an entirely crystallised mass, in which not the least of the vitreous character is discernible.

Such are the most ordinary characters of the crystallisation; but frequently others are observed, which certainly

tainly are the effect of chance, and which well deserve to be attended to on account of their varieties *.

I have some pieces of glass in which crystals are to be observed, of such extreme tenuity, that they can scarcely be discerned with a magnifying glass. These are prisms diverging all from the same centre, and forming stars, many of which are not quite a millimetre in thickness; united together, they appear like a light cloud in the paste of the glass.

Some pieces exhibit the appearance of a saline crust applied to a foreign body with which the glass was in contact. In some this crust, composed of striated clusters, appears to advance more and more, and gain upon the glass.

Finally, there is another variety, which perhaps is more curious than any of those above mentioned; I mean that in which are perceived, in the midst of the paste of the glass, centres of crystallisation like peas, and nearly resembling grains. These are small spheres, flattened at both ends, with a small protuberance in the middle of each depression. The sides have ribs like the seed of capucine, and these ribs are always six in number.

My intention is, when I shall have been able to procure a sufficient number of this singular kind of crystals, to analyse them, in order to ascertain what earth it is that affects so singular a form.

Such are, in brief, the principal facts which characterise the precipitation and the crystallisation of glass. It is evident that they are of the same nature with those produced by the cementation indicated by Reaumur, and

* M. Sage possesses a piece of crystallised glass in basaltic prisms with six sides, and entirely devitrified.

that

that the result is always a more or less complete devitrification.

When the glass is devitrified, it has no longer the vitreous fracture, but a granulated one; it has no transparency, and it perfectly resembles a stone; it becomes a better conductor of caloric and of electricity. Finally, it is no longer susceptible of fusion by the same degree of fire; and, in order to restore it more easily to the vitreous state, it is necessary previously to pound it, so as to bring again into contact the substances which during the crystallisation had separated from each other, and could no longer serve mutually as fluxes to one another.

I wish that the novelty of several of the facts which I have recorded, and the conclusions which I have drawn from them, in proving that the crystallisation of the glass is a devitrification, may appear sufficiently interesting to engage the attention of scientific men: I do not doubt that they will give them occasion to make many inferences which have escaped me, or which the limits of a single memoir do not permit me to particularise. The resemblance between my specimens of devitrified glass and certain lavas; the possibility that other lavas may have undergone a more complete devitrification, by a longer protracted cooling in the volcanic currents, which have been seen to flow, or at least to remain fluid for whole years under crusts already cooled; all this induces me to believe that these facts may afford the means of explaining many phenomena of geology respecting which philosophers are not as yet agreed, because nothing could make them believe that stones had previously been glass.

Of

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Of the Utility to be derived from the Ore of Chromate of Iron found in France, by employing it for the Fabrication of a superb Yellow Colour for Painting.

By M. Drappier.

From the Journal des Mines.

THE discovery made by M. Vauquelin of a new metal in the state of acid in the red lead of Siberia, since termed *chromate of lead*, and the property which he discovered in this acid of combining with the alkalis, and of precipitating lead in a yellow state from its solutions in the acids, have enabled M. Tassaert to prove that this metal is not a stranger to the soil of France, and that it will be possible henceforward to furnish the art of painting, whether in oil or enamel, with colours which unite beauty with permanency. This chemist, having had occasion to examine a mineral found in the department of the Var, and sent to the Council of Mines by M. Pontier, found that, instead of containing zinc, as had been suspected, it contained iron combined with chromic acid. This discovery has since been confirmed by M. Vauquelin, who published an accurate analysis of this mineral in the Journal des Mines.

One of the principal properties of the Siberian chromate of lead is, that it furnishes, by simple trituration, an orange-yellow colour, which is very much in request among the Russian painters. This colour is hardly known to our painters, probably on account of its excessive price, and particularly its scarcity; but the discovery of the chromate of iron affords us the means of procuring it for them in abundance, and at a far more moderate price. It is with this view that we have tried to

compose

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compose the chromate of lead from its constituent principles, and that we are now about to give an account of the process which appeared to us the most economical, and to afford results more satisfactory than those which had hitherto been obtained. Unfortunately, the aggregation of the molecules of the chromate of iron, and the presence of the alumine, which appears, according to M. Vauquelin, to exist in it in triple combination, tend to render the process tedious and pretty expensive. We hope, however, that it will be possible to substitute an easier one in its place, or at least to simplify it.

After the chromate of iron has been well pulverized, mix it with three parts of dried carbonate of soda, or of potash of commerce, as free as possible from the foreign matters which may be found in it. Introduce the mixture into a crucible, and then expose it, for the space of half an hour, to a fire capable of reducing the oxyds of lead. Pour upon the matter, after having carefully triturated and washed it, sulphuric acid diluted with four times its weight of water, adding the acid a little in excess. Wash the mixture till it has no longer any taste. Thus we shall obtain a brown granulated matter, which may be employed with much success, either to communicate very beautiful green tinges to glass, by means of fusion, or to prepare chromate of potash or of soda, by treating it, as before, with two or three parts of nitrate of potash, or of dried carbonate of soda. In this second operation, if the decomposition has succeeded well, the matter which is in the crucible must be well fused, its surface must be of a deep green colour, and its fracture very smooth, and of a pea-green hue. In this state it is very soluble in water, and the solution, after having been filtrated, is of a fine yellow colour.

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If the chromate of potash does not contain alkali in excess, which generally happens when the nitrate of potash is employed, we may, without any other preparation, employ it for precipitating the lead from its solution in the nitric acid, and obtain a superb yellow colour: it may happen that an excess of lead is precipitated, in which case the tinge is a little weakened; in order to render it more intense, without injuring its purity, we may employ with advantage acetous acid, which carries off the excess of lead without dissolving the chromate.

When it contains an excess of alkali, it must be saturated by means of nitric acid, and the solution filtrated after it has deposited a large quantity of alumine and of silex proceeding from the crucibles in which the operation has been performed; we may also free it from these earths by diluting the solution of the alkaline chromate with water, and leaving it exposed to the air for several days, or else by saturating it with nitric acid, and afterwards evaporating it to dryness. The oxygenated muriatic acid also produces this precipitation, and the chromate of lead which is afterwards obtained is only the more brilliant.

The chromate of potash prepared with nitre gives a reddish black precipitate with the nitrate of mercury instead of a fine red precipitate, which is obtained when we employ the purified chromate of potash. Supposing that this difference was occasioned by nitrous acid which the chromate might contain, we gradually poured nitric acid into the solution, and saw to our surprise that the liquor disengaged nitrous gas, and successively assumed all the tinges from the ruby-red to the fine emerald-green. The red colour is developed the first, and this is suc-

succeeded by the violet, the blue, all the shades of the aigue-marine, and, finally, the beautiful emerald-green.

By adding an excess of nitric acid, or of super-oxygenated muriate of potash, we obtain again, after having evaporated to dryness, and re-dissolved in water, chromate of iron of considerable purity, and exempt from earthy substances.

But in order to obtain this re-agent for the laboratories, we think it better to decompose in the humid way, and by means of the saturated carbonate of potash, the chromate of lead obtained by the process above indicated.

We shall conclude by observing, that the chromate of lead thus prepared is of a purer yellow colour than the native chromate of lead. This circumstance cannot fail to render it more valuable in the eyes of painters, as they find much difficulty in procuring pure tints, whereas they compose the mixed tints with great ease. As to its permanency, some trials authorise us to believe that this colour may be ranked among those which possess this property in an eminent degree; but it remains for practice and time to determine in how far this opinion is well-founded.

Observations on the two Processes employed for the Fabrication of Verdet, Verdegris, or Acetite of Copper.

By M. CHAPTAL.

(Extracted from the Memoirs of the Institute.)

TWO processes are known for the fabrication of the acetite of copper.

The one, which has been in use at Montpellier from time immemorial, consists in causing the marc of grapes to ferment, and covering it with the plates of copper, in order to oxydate the metal.

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The other, which has been employed for some years past at Grenoble, and in its environs, consists merely in sprinkling distilled vinegar upon the plates of copper, disposed in tubes, and by this means developing and promoting their oxydation.

The verdegris of Montpellier is greasy, pastey, loses half of its weight in drying; it presents in its fracture silky points, like some pieces of malachite; it has little solubility in water.

The verdegris of Grenoble is drier, of a more marked greenish blue; it has a crystal-like fracture, and it is more soluble in water.

The first is a little cheaper in commerce; it is employed with success in the operations of painting.

The second is preferred for the processes of dyeing; it gives greater vivacity to the colours, and a smaller quantity of it is required for the composition of the mordants.

On what do these differences depend? The solution of this problem is the object which I have proposed to myself.

Experiment I. A hundred parts of verdet of Grenoble, distilled in a retort with the pneumato-chemical apparatus, gave as follows.

1. Water slightly acid, having a metallic taste and smell.

2. White vapours which condensed themselves in the receiver.

3. Carbonic acid.

4. Acetous acid, very strong, very transparent, of a green colour, and of a penetrating odour.

5. The exhausted residuum of the retort afforded only copper and charcoal by its analysis and reduction.

Result

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Result of the Analysis of 100 *Parts of Verdet of Grenoble.*

Carbonic Acid	9.10	
Water slightly acidulous	13.05	
Strong and coloured acid	53.95	100.
Copper	20.90	
Carbon	3.00	

Experiment II. A hundred parts of verdet of Montpellier, distilled in a retort with pneumato-chemical apparatus, gave as follows:

1. Water, slightly acid, of an empyreumatic smell.

2. Carbonic acid, mixed with a small quantity of hydrogene gas.

3. Acetous acid, of a yellowish colour, a strong empyreumatic smell, very weak and little concentrated.

4. The residuum of the retort yielded copper and charcoal.

Result of the Analysis of 100 *Parts of Verdet of Montpellier.*

Carbonic acid	8.00	
Acetous acid, very weak and highly empyreumatic	65.15	100.
Copper	22.50	
Carbon	4.35	

It appears from the above experiments, which represent the medium result of my operations upon different kinds of verdets; 1, that the verdet of Montpellier is less soluble in water than that of Grenoble; 2, that that of Montpellier contains much less pure acetous acid than that of Grenoble; 3, that that of Montpellier is mixed with a portion of extractive matter, which is not found in the verdet of Grenoble; 4, that the former yields a little more copper and carbon than the latter.

By

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By a comparative consideration of the processes of the fabrication, we shall easily discover the cause of these differences.

1. The marc of grapes, which is used at Montpellier, is slightly acid, by remaining upon the copper it oxydates the metal, and deposits a layer of extractive matter upon the plates.

2. The acetous acid, employed at Grenoble, at first oxydates the metal, and the new acid which is added dissolves the oxyd.

The verdet of Montpellier is therefore a mixture of oxyd of copper, extractive matter, and acetite of copper.

That of Grenoble contains hardly any thing but acetite of copper.

From what precedes, we may deduce the cause of the difference which the arts have assigned to these two kinds of verdet.

That of Montpellier, which is very agreeably coloured, gluey and pastey by reason of its extractive matter, is employed with advantage in painting.

That of Grenoble, which is more soluble, more pure, in a kind of medium between the verdet and the crystals of Venus, is preferred for the operations of dyeing.

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List of Patents for Inventions, &c.

(Continued from Page 392.)

JOHN ROBERT IRVING, of the city of Edinburgh, Advocate, and ISABELL LOVI, of the city of Edinburgh aforesaid, Worker in Glass; for an improved apparatus for determining the specific gravity of fluid bodies, and the relation that their weight bears to a given measure. Dated March 9, 1805.

JOHN BAPTISTE DENIZE, of West-street, Somers Town, in the county of Middlesex, Chemist; for a mode of procuring a greater quantity of resinous, bituminous, and oily substances, from various articles. Dated March 9, 1805.

ARCHIBALD BLAIR, of Bayford, in the county of Herts, Esquire; for a method of retaining cotton and other elastic substances when pressed by means of wrappers. Dated March 9, 1805.

WILLIAM BELL, of the town of Derby, Engineer; for an improved method of manufacturing blanks or moulds for knife, razor, and scissar blades, and various other edged tools, and of forks, files, and nails. Dated March 9, 1805.

THOMAS JONES, of Bilstone, in the county of Stafford, Japanner; for compositions for the purpose of making trays, waiters, and various other articles, and new modes or methods of manufacturing the same, that is to say, by presses and stamps. Dated March 23, 1805.

RICHARD BRANDON, the elder, of Lucas-street, in the parish of St. Mary Rotherhithe, in the county of Surrey; for a composition from British herbs and plants for the cure of the evil, scrophula, scurvy, leprosy, gout, and rheumatism, and which he has denominated and called *Brandon's British Constitutional Pills, and Liquid and*

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and Botanic Ointment, and which in upwards of 3000 cases has been attended with the most unparallelled success in the course of the last nine months.
Dated March 26, 1805.

JONATHAN HORNBLOWER, of the borough of Penryn, in the county of Cornwall, Engineer; for a steam-wheel, or engine for raising water, and for other useful purposes, in arts and manufactures, by means of steam. Dated March 26, 1805.

STUART ARNOLD, of Wakefield, in the county of York, Gentleman; for a chimney safe-guard, for the preservation of houses and buildings from fire, robbery, and foul air. Dated March 26, 1805.

GEORGE ALEXANDER BOND, of Hatton Garden, in the parish of St. Andrew Holborn, in the county of Middlesex, Gentleman; for certain improvements in the construction of clocks and other time pieces, whereby they are rendered of much greater utility and service both by sea and land, than any heretofore made use of. Dated March 26, 1805.

JOB RIDER, of Belfast, in the county of Antrim, in that part of the united kingdom called Ireland, Clock and Watch-maker; for certain improvements on the fusee engine. Dated March 26, 1805.

WILLIS EARLE, of Liverpool, in the county of Lancaster, Merchant; for improvements in the mode of constructing and working steam-engines. Dated March 26, 1805.

SIR GEORGE WRIGHT, of Hay Lodge, in the county of Essex, Baronet; for an instrument or machine for cutting out of solid stone, wood, or other materials, pillars and tubes, either cylindrical or conical, with great saving of labour and materials. Dated March 30, 1805.

END OF THE SIXTH VOLUME, SECOND SERIES.

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